MODULE – 5

Physics Lecturers

STUDY AND APPLICATION OF MATTER AND ELECTRICITY

2016-17

SCERT
स्वाध्यायात्मा प्रमदः
राज्य शैक्षिक अनुसंधान एवं प्रशिक्षण परिषद
वरूण मार्ग, डिफेंस कॉलोनी, नई दिल्ली-110024

MODULE - 5
for
PHYSICS LECTURERS

2016-17

STUDY AND APPLICATION OF MATTER AND ELECTRICITY

State Council of Educational Research and Training

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Module- 5

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ABOUT THE MODULES.....

The series of Six Modules of physics at the Higher Secondary Stage has been developed with a view that the school education is crucial and challenging as it is a transition from general science to discipline-based curriculum. The recommendations of National Curriculum Framework-2005 have been followed, keeping the disciplinary approach with rigour and depth, appropriate to the comprehension level of learners. It is expected that, these six modules will help teachers teaching XI and XIIth classes will develop an interest in the learners to study Physics as a discipline and inculcate in learners the abilities, useful concepts of Physics in real-life situations for making learning of Physics relevant, meaningful and interesting. The learner is expected to realize and appreciate the interface of Physics with other disciplines.

RATIONALE

Physics is being offered as an elective subject at the higher secondary stage of school education. At this stage, the students take up Physics, as a discipline, To achieve the primary aim of the Curriculum - to create interest in the learner, to pursue their future careers in basic sciences-physics. This demands sufficient conceptual background of Physics which would eventually make them competent to meet the challenges of academic and professional courses after the higher secondary stage.The six modules is an effort in reforming and updating the Physics curriculum based on the feedback received from the teachers during earlier INSET programmes organised by SCERT time to time. The educational and curricular concerns and issues provided in the National Curriculum Framework-2005, is addressed to a greater extent.

SALIENT FEATURES

- Emphasis on basic conceptual understanding of content.
- Promoting process-skills, problem-solving abilities and applications of Physics concepts/content, useful in real-life situations for making Physics learning more relevant, meaningful and interesting.
- Emphasis on Numerical analysis.
- Emphasis on Technical Educational Movie – Analysis from Physics and scientific approach
- Emphasis on Physics-related technological/industrial aspects to cope up with changing demand of society committed to the use of Physics, technology and informatics.
- Providing logical sequencing of the concepts and their linkages for better learning and matching the concepts/content with comprehension level of the learners.
- Reducing the curriculum load by eliminating overlapping of concepts/content within the discipline of Physics or with other disciplines; reducing the descriptive portion and providing suitable formulation/depth of treatment appropriate to the comprehension level of learners, making room for contemporary core - topics and emerging curricular areas in Physics.
- The content are so sequenced as to provide different dimensions of Physics as a discipline. Each Module has been arranged with a topic, content related practical work (one core experiment, two activities to be evaluated)
- There is an imperative need for evaluating the learners through Continuous and Comprehensive Evaluation of various concepts covered in a Unit.

With this background, the Physics curriculum at the higher secondary stage

attempts to:

- Strengthen the concepts developed at the secondary stage to provide firm ground work and foundation for further learning Physics at the tertiary level more effectively and learning the relationship with daily-life situations;
- Develop conceptual competence in the learners and make them realize and appreciate the interface of Physics with other disciplines;
- Expose the learners to different processes used in Physics-related industrial and technological applications;

• Develop process-skills and experimental, observational, manipulative, decision-making and investigatory skills in the learners;

• Promote problem-solving abilities and creative thinking to develop interest in the learners in the study of Physics as a discipline;

• Understand the relationship between nature and matter on scientific basis, develop positive scientific attitude, and appreciate the contribution of Physics towards the improvement of quality of life and human welfare;

• Physics teaching-learning at the higher secondary stage enables the learners to comprehend the contemporary knowledge and develop aesthetic sensibilities and process skills. The experimental skills and process-skills developed together with conceptual Physics knowledge prepare the learners for more meaningful learning experiences and contribute to the significant improvement of quality of life. The learners would also appreciate the role and impact of Physics and technology, and their linkages with overall national development.

PGT-PHYSICS	
S.No.	**TITLE**
Module-1	**Micro Level Understanding of Physics in Macroscopic View** • Free Body Diagram and Resolution of Vector • Electrostatic Properties of Dielectrics/Conductors • Potentiometer • Open Ended Questions • Marking Scheme and Question Paper
Module-2	**Physics of Spherical and Circular Surfaces** • Rolling Friction • Concept of COG and COM • Experiment to find Focal Length of Mirror • Experiment to find Focal Length of a Convex Lens • Open Ended Questions • Marking Scheme and Question Paper.
Module-3	**Study of Interaction among Particles and Waves** • Superposition of Waves • Magnetism in Action • Fun with Pendulum • Open Ended Questions • Marking Scheme and Question Paper
Module-4	**Energy Transport with and without Molecules** • Heat Transfer • Thermodynamics • Communication Systems

	• Resonance of Air Columns • Use of Media in Enhancing Physics Teaching-Learning Strategies • Learning Outcome - How Teachers can Educate their Students on the Science of 'Interstellar' • Marking Scheme and Question Paper
Module-5	**Study and Application of Matter and Electricity** • Fluids in Motion and Energy Conservation • Electrical Capacitance • Sonometer (Experiment) • Use of Media in Enhancing Physics Teaching • Marking Scheme and Question Paper
Module-6	**Particle Motion to Wave Motion** • Projectile Motion • Qualitative Analysis of Wave Optics • Capillary Rise Method • Use of Media in Enhancing Physics Teaching-Learning Strategies • Marking Scheme and Question Paper

Abstract of the six Modules

Module: 1 – Micro Level Understanding of Physics in Macroscopic View

Mathematics as a field influences Physics to a greater extent. On the contrary, one can also say that Physics adds meaning to Mathematics. This module requires a greater mathematical strength to understand and impart in a classroom situation. It covers the free body diagram where many forces are involved, resolution of vectors-force, indication of electric field in dielectric and conductors. These topics demand utmost dedication and will to learn and apply in the situations that evolve in due course. Activity on potentiometer is taken for in depth study with hands-on-tools to overrule the practical problems faced in the laboratory. This segment will enhance your skills in the experimentation and thereby the theory also will get strengthened. Applications and computational skills for problem solving have been stressed in the question papers now-a-days. Rather than solving a single question with values if one can generalize the problem the student can in fact do a lot of numerical questions and will enhance his confidence in Physics. This will also encourage the student to take up Physics as a subject in higher classes. You also stand out to gain a greater insight into physics by learning to analyse and interpret the data.

Happy using the module and Learning the content the way it is said.

Module 2 – Physics of Spherical and Circular Surfaces

This module attempts to help teachers to integrate scientific practices into the learning of Physics. A sound knowledge and understanding of the core observations, concepts and quantitative theoretical structures that constitute our contemporary understanding of the concept is aimed at here. This module emphasize on problem solving skills with nuances and generalization. Care has been taken to cover all areas in the numerical practice across the modules.Here an introduction to magnetic effect of current, Ampers' circuital law, its application are discussed in detail besides the most important aspect of transportation - rolling motion.The simple way by which Rolling can be introduced within the limitations of CBSE Board Syllabus is followed. The activities of optics and optical benches are taken from the practical side as many students fail to make an image without Parallax. The methods that will be shown hands-on will facilitate the teacher and in-turn he student in their care.

Happy using the module and Learning the content the way it is said.

Module 3 – Study of Interaction among Particles and Waves

Magnetism and Waves are two topics that fail to induce any interest in the student because of the way it is introduced. So a lucid style and a comparative approach on the interaction of waves is done efficiently. Numerical questions are open ended and are to be solved with care such that a similar twisted questions are done with ease. The numerical session in groups will enhance the teaching ability as the teachers in the group may provide multiple approach to the same query or situation. In a way one may also understand the defect in our organs like the eye and ear.

A normal ear retains the sound for about 1/10 of a second.

A human eye can observe an event if 24 frames are shown per second.

A simple experiment which may provide a lot of scope for the guided projects is a Simple pendulum. This is dealt with in detail so that the many students can be given one aspect of the experiment for the investigatory project.

Happy using the module and Learning the content the way it is said.

Module 4 – Energy Transport with and without Molecules

A great philosopher has said “Change is a constant in life”. Keeping these words in mind,we as teachers keep learning and implementing in the classes the best of the teaching practices and the simplified ways and means to understand any topic. The topics of Heat and Thermodynamics, Communication systems and some experiments on Resonance are on the neglected list over a period of time. The student tries to do the minimum work on these areas and the absence of intent hinders the learning process. The fundamental aspects of the topics transfer of Heat and Thermodynamics is dealt with in a manner that will ease the difficulty in learning. The degrees of freedom in different molecular formation can be done with ease with idea incorporated here. The experiment on the Resonance tube apparatus is taken for a complete demonstration and this will ease the difficulty in performing them in the school. The content of the chapter – Communication Systems is available in plenty. But how to make the student to understand the same is a difficult task which was expressed by the teachers in the previous INSET programme. The content may look the same way as the rest but as you attend the session you may feel the way the content be used for the student to score full marks allotted for the chapter. Following a regular pattern may make a boredom.To avoid there should be certain traits we need to imbibe as teachers from time to time.For the first time incorporating Movie Session for learning new traits to be used in class,learn the scientific ways of improving Observation and Interpretation skills and the way technological tools can be used in the teacher training programme is done. The movie that is to be shown here partly is to bring certain changes in your classroom so that the good traits from the reel world is a reality and helps the student community. The attempt by SCERT in providing Freedom for the content developers in bringing necessary variations in the regular topics that has been provided will make this module a unique one.

Happy using the module and Learning the content the way it is said.

Module 5 – Study and Application of Matter and Electricity

Time and again there has been a difficulty felt in the classroom in dealing with some interesting but felt hard topics in the class XI and XII Physics syllabus. Some of these areas include Bernoulli’s theorem and Capacitance. They play a great role in the scoring pattern of the student and to a greater extent induce interest in our subject. An attempt is made here to simplify and apply to a greater extent in the classroom. Why a ball spinned around rises up in the sky when the student is playing cricket is an unanswered question in his mind. The module here with you is an answer to bring the spinning ball into the classroom. Various other examples like the quantifying the volume of water that is being received from a canal outside Delhi will bring reality to classrooms. The capacitors as a energy storage device and their combinations in various circuits have revolutionised the field of communication. Unless and until the student is informed of the daily use of capacitors while doing the topic of Electrostatics - Capacitance it is difficult to make them mentally prepared for conceptualisation. The numerical questions given as practice questions are to prepare the student through the teachers for the board examination. In the practical part there is apprehension in the handling of Sonometer. This induced us to build a session on Sonometer. The session will be hands-on on the stage with the recording of results highlighting the intricacies of the practical handling of Sonometer. One may understand that simple recording is not doing experiment but to understand the nuances of the topic is of prime focus. Following a regular pattern in the teaching –learning process may make a boredom. To avoid there should be certain traits we need to imbibe as teachers from time to time. For the first time incorporating Movie Session for learning new traits to be used in class, learn the scientific ways of improving Observation and Interpretation skills and the way technological tools can be used in the teacher training programme is done. The movie that is to be shown here partly is to bring certain changes in your

classroom so that the good traits from the reel world is a reality and helps the student community. The attempt by SCERT in providing Freedom for the content developers in bringing necessary variations in the regular topics that has been provided will make this module a unique one.

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Module 6 – Particle Motion to Wave Motion

To take interest, identify, acknowledge ,unfolding curiosities ,seeking for explanations and reasons is the real fun of Science. Bringing down the observations to find theoretical justification and explanations to the observations makes the difficult part of the subject.Perception is the key reference of interpreting the world around . Inculcating the ability of qualitative understanding and idea is another bless that the students deserve to be served.Throwing a ball while playing a simple game makes it move along a curved path that most people know, the purpose is to create fascination and curiosity of the level that the child feels to interrogate every specification that the child observes and seeks for a theory that supports the same. The projectile motion faces lack of connect of how the various parameters like horizontal range , maximum height serves to make student's life easy.The topic aims to extend and connect the theoretical findings with its applications in the real world to enable students to appreciate the value of the various derivations ,their findings and understanding from the same. To make someone realize the existence of something for which first hand experience is difficult to attain is a task,which if accomplished is a real achievement.Wave optics being one of the most mind opening experience to realize the possibilities of what you observe in nature, the qualitative description of the same has been taken up in the module.The purpose stays as basic as to widen the vision and possibilities that a student can incorporate to extract understanding and knowledge from nature.For the things there in books and theories are hard to experience and trust in real life , experiencing that perception being existing for real people gives a better idea of authentic existence of the same . Movies based on Scientific ideology to avail critical thinking to the learners , so as to go down the the line to the thought process of the person who had thought about this edge of the Scientific development and progress is another concern of the module.

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PHYSICS (Code No. 042)

Senior Secondary stage of school education is a stage of transition from general education to discipline-based focus on curriculum. The present updated syllabus keeps in view the rigour and depth of disciplinaw approach as well as the comprehension level of learners. Due care has also been taken that the syllabus is comparable to the international standards. Salient features of the syllabus include:

- Emphasis on basic conceptual understanding of the content.
- Emphasis on use of SI units, symbols, nomenclature of physical quantities and formulations as per international standards.
- Providing logical sequencing of units of the subject matter and proper placement of concepts with their linkage for better learning.
- Reducing the curriculum load by eliminating overlapping of concepts/content within the discipline and other disciplines.
- Promotion of process-skills, problem-solving abilities and applications of Physics concepts.

Besides, the syllabus also attempts to

- strengthen the concepts developed at the secondary stage to provide firm foundation for further learning in the subject.
- expose the learners to different processes used in Physics-related industrial and technological applications.
- develop process-skills and experimental, observational, manipulative, decision making and investigatory skills in the learners.
- promote problem solving abilities and creative thinking in learners.
- develop conceptual competence in the learners and make them realize and appreciate the interface of Physics with other disciplines.

PHYSICS (Code N0. O42)

COURSE STRUCTURE

Class XI (Theory) (2016-17)

Time: 3 hrs. **Max Marks: 70**

		No. of Periods	Marks
Unit-I	**Physical World and Measurement**	10	23
	Chapter-1: Physical World		
	Chapter-2: Units and Measurements		
Unit-II	**Kinematics**	24	
	Chapter-3: Motion in a Straight Line		
	Chapter-4: Motion in a Plane		
Unit-III	**Law of Motion**	14	
	Chapter-5: Law of Motion		
Unit-IV	**Work,Energy and Power**	12	17
	Chapter-6: Work,Energy and Power		
Unit-V	**Motion of System of Particles and Rigid Body**	18	
	Chapter-7: System of Particles and Rotational Motion		
Unit-VI	**Gravitation**	12	
	Chapter-8: Gravitation		
Unit-VII	**Properties of Bulk Matter**	24	20
	Chapter-9: Mechanical Properties of Solids		
	Chapter-10: Mechanical Properties of Solids		
	Chapter-11: Mechanical Properties of Solids		
Unit-VIII	**Thermodynamics**	12	
	Chapter-12: Thermodynamics		
Unit-IX	**Behaviour of Perfect Gases and Kinetic Theory of Gases**	08	
	Chapter-13: Kinetic Theory		
Unit-X	**Oscillations and Waves**	26	20
	Chapter-14: Oscillations		
	Chapter-15: Waves		
Total		160	70

Unit I: Physical World and Measurement **10 Periods**

Chapter-1: Physical World

Physics-scope and excitement; nature of physical laws; Physics, technology and society.

Chapter-2: Units and Measurements

Need for measurement: Units of measurement; systems of units; SI units, fundamental and derived units. Length, mass and time measurements; accuracy and precision of measuring instruments; errors in measurement; significant figures.

Dimensions of physical quantities; dimensional analysis and its applications.

Unit II: Kinematics **24 Periods**

Chapter-3: Motion in a Straight Line

Frame of reference, Motion in a straight line: Position-time graph, speed and velocity.Elementary concepts of differentiation and integration for describing motion, uniform and non-uniform motion, average speed and instantaneous velocity, uniformly accelerated motion,velocity - time and position-time graphs.

Relations for uniformly accelerated motion (graphical treatment).

Chapter-4: Motion in a Plane

Scalar and vector quantities; position and displacement vectors; general vectors and their notations; equality of vectors; multiplication of vectors by a real number; addition and subtraction of vectors; relative velocity; Unit vector; resolution of a vector in a plane, rectangular components, Scalar and Vector product of vectors.

Motion in a plane, cases of uniform velocity and uniform acceleration-projectile motion,uniform circular motion.

Unit III: Laws of Motion **14 Periods**

Chapter-5: Laws of Motion

Intuitive concept of force; Inertia; Newton's first law of motion; momentum and Newton's second law of motion; impulse; Newton's third law of motion.

Law of conservation of linear momentum and its applications.

Equilibrium of concurrent forces; Static and kinetic friction; laws of friction; rolling friction;lubrication.

Dynamics of uniform circular motion: Centripetal force, examples of circular motion (vehicle on a level circular road, vehicle on a banked road).

Unit IV: Work, Energy and Power **12 Periods**

Chapter-6: Work, Engery and Power

Work done by a constant force and a variable force; kinetic energy; work-energy theorem;power.

Notion of potential energy; potential energy of a spring; conservative forces: conservation of mechanical energy (kinetic and potential energies); non-conservative forces: motion in a vertical circle; elastic and inelastic collisions in one and two dimensions.

Unit V: Motion of System of Particles and Rigid Body **18 Periods**

Chapter-7: System of Particles and Rotational Motion

Centre of mass of a two-particle system; momentum conservation and centre of mass motion.Centre of mass of a rigid body; centre of mass of a uniform rod.

Moment of a force; torque; angular momentum; law of conservation of angular momentum and its applications.

Equilibrium of rigid bodies; rigid body rotation and equations of rotational motion; comparison of linear and rotational motions.

Moment of inertia; radius of gyration; values of moments of inertia for simple geometrical objects (no derivation). Statement of parallel and perpendicular axes theorems and their applications.

Unit VI :Gravitation **12 Periods**

Chapter-8: Gravitation

Kepler's laws of planetary motion, universal law of gravitation.

Acceleration due to gravity and its variation with altitude and depth.

Unit VII: Properties of Bulk Matter **24 Periods**

Chapter-9: Mechanical Properties of Solids

Elastic behaviour; Stress-strain relationship; Hooke's law; Young's modulus; bulk modulus; shear modulus of rigidity; Poisson's ratio; elastic energy.

Chapter-10: Mechanical Properties of Fluids

Pressure due to a fluid column; Pascal's law and its applications (hydraulic lift and hydraulic brakes); effect of gravity on fluid pressure.

Viscosity; Stokes' law; terminal velocity; streamline and turbulent flow; critical velocity;Bernoulli's theorem and its applications.

Surface energy and surface tension; angle of contact; excess of pressure across a curved surface; application of surface tension ideas to drops, bubbles and capillary rise.

Chapter-11: Thermal Properties of Matter

Heat; temperature; thermal expansion; thermal expansion of solids, liquids and gases;anomalous expansion of water; specific heat capacity; Cp, Cv - calorimetry; change of state -latent heat capacity.

Heat transfer-conduction, convection and radiation; thermal conductivity; qualitative ideas of Blackbody radiation; Wein's displacement Law; Stefan's law; Green house effect.

Unit VIII: Thermodynamics **12 Periods**

Chapter-12: Thermodynamics

Thermal equilibrium and definition of temperature (zeroth law of thermodynamics); heat, work and internal energy. First law of thermodynamics; isothermal and adiabatic processes.

Second law of thermodynamics: reversible and irreversible processes; Heat engine and refrigerator.

Unit IX: Behaviour of Perfect Gases and Kinetic Theory of Gases **08 Periods**

Chapter-13: Kinetic Theory

Equation of state of a perfect gas; work done in compressing a gas.

Kinetic theory of gases - assumptions, concept of pressure. Kinetic interpretation of temperature; rms speed of gas molecules; degrees of freedom, law of equi-partition of energy (statement only) and application to specific heat capacities of gases; concept of mean free path, Avogadro's number.

Unit X: Oscillations and Waves **26 Periods**

Chapter-14: Oscillations

Periodic motion - time period, frequency, displacement as a function of time, periodic functions.

Simple harmonic motion (S.H.M) and its equation; phase; oscillations of a loaded spring-restoring force and force constant; energy in S.H.M. Kinetic and potential energies; simple pendulum derivation of expression for its time period.

Free, forced and damped oscillations (qualitative ideas only), resonance.

Chapter-15: Waves

Wave motion: Transverse and longitudinal waves, speed of wave motion, displacement relation for a progressive wave, principle of superposition of waves, reflection of waves, standing waves in strings and organ pipes, fundamental mode and harmonics, Beats, Doppler effect.

PRACTICALS Total **Periods: 60**

The record, to be submitted by the students, at the time of their annual examination, has to include:

- Record of at least 15 Experiments [with a minimum of 6 from each section], to be performed by the students.
- Record of at least 5 Activities [with a minimum of 2 each from section A and section B], to be demonstrated by the teachers.
- Report of the project to be carried out by the students.

EVALUATION SCHEME

Time Allowed: Three hours **Max. Marks: 30**

Two experiments one from each section	8+8 Marks
Practical record (experiment and activities)	6 Marks
Investigatory Project	3 Marks
Viva on experiments, activities and project	5 Marks
Total	**30 Marks**

SECTION-A

Experiments

1. To measure diameter of a small spherical/cylindrical body and to measure internal diameter and depth of a given beaker/calorimeter using Vernier Callipers and hence find its volume.

2. To measure diameter of a given wire and thickness of a given sheet using screw gauge.

3. To determine volume of an irregular lamina using screw gauge.

4. To determine radius of curvature of a given spherical surface by a spherometer.

5. To determine the mass of two different objects using a beam balance.

6. To find the weight of a given body using parallelogram law of vectors.

7. Using a simple pendulum, plot its L-T^2 graph and use it to find the effective length of second's pendulum.

8. To study variation of time period of a simple pendulum of a given length by taking bobs of same size but different masses and interpret the result.

9. To study the relationship between force of limiting friction and normal reaction and to find the co-efficient of friction between a block and a horizontal surface.

10. To find the downward force, along an inclined plane, acting on a roller due to gravitational pull of the earth and study its relationship with the angle of inclination 9 by plotting graph between force and sinθ.

Activities

(for the purpose of demonstration only)

1. To make a paper scale of given least count, e.g., 0.Zcm, 0.5 cm.

2. To determine mass of a given body using a metre scale by principle of moments.

3. To plot a graph for a given set of data, with proper choice of scales and error bars.

4. To measure the force of limiting friction for rolling of a roller on a horizontal plane.

5. To study the variation in range of a projectile with angle of projection.

6. To study the conservation of energy of a ball rolling down on an inclined plane (using a double inclined plane).

7. To study dissipation of energy of a simple pendulum by plotting a graph between square of amplitude and time.

SECTION-B

Experiments

1. To determine Young's modulus of elasticity of the material of a given wire.

2. To find the force constant of a helical spring by plotting a graph between load and extension.

3. To study the variation in volume with pressure for a sample of air at constant temperature by plotting graphs between P and V, and between P and 1/V.

4. To determine the surface tension of water by capillary rise method.

5. To determine the coefficient of viscosity of a given viscous liquid by measuring terminal velocity of a given spherical body.

6. To study the relationship between the temperature of a hot body and time by plotting a cooling curve.

7. To determine specific heat capacity of a given solid by method of mixtures.

8. To study the relation between frequency and length of a given wire under constant tension using sonometer.

9. To study the relation between the length of a given wire and tension for constant frequency using sonometer.

10. To find the speed of sound in air at room temperature using a resonance tube by two resonance positions.

Activities

(for the purpose of demonstration only)

1. To observe change of state and plot a cooling curve for molten wax.

2. To observe and explain the effect of heating on a bi-metallic strip.

3. To note the change in level of liquid in a container on heating and interpret the observations.

4. To study the effect of detergent on surface tension of water by observing capillary rise.

5. To study the factors affecting the rate of loss of heat of a liquid.

6. To study the effect of load on depression of a suitably clamped metre scale loaded at (i) its end (ii) in the middle.

7. To observe the decrease in presure with increase in velocity of a fluid.

Practical Examination for Visually Impaired Students

Class XI

Note: Same Evaluation scheme and general guidelines for visually impaired students as given for Class XII may be followed.

A. Items for Identification/Familiarity of the apparatus for assessment in practicals(All experiments)

Spherical ball, Cylindrical objects, vernier calipers, beaker, calorimeter, Screw gauge, wire, Beam balance, spring balance, weight box, gram and milligram weights, forceps, Parallelogram law of vectors apparatus, pulleys and pans used in the same ‘weights’ used, Bob and string used in a simple pendulum, meter scale, split cork, suspension arrangement, stop clock/stop watch, Helical spring, suspension arrangement used, weights, arrangement used for measuring extension, Sonometer,Wedges, pan and pulley used in it, ‘weights’ Tuning Fork, Meter scale, Beam balance, Weight box, gram and milligram weights, forceps, Resonance Tube, Tuning Fork, Meter scale, Flask/Beaker used for adding water.

B.List of Practicals

1. To measure diameter of a small spherical/cylindrical body using vernier calipers.

2. To measure the internal diameter and depth of a given beaker/calorimeter using vernier calipers and hence find its volume.

3. To measure diameter of given wire using screw gauge.

4. To measure thickness of a given sheet using screw gauge.

5. To determine the mass of a given object using a beam balance.

6. To find the weight of given body using the parallelogram law of vectors.

7. Using a simple pendulum plot L-T and L-T2 graphs. Hence find the effective length of second's pendulum using appropriate length values.

8. To find the force constant of given helical spring by plotting a graph between load and extension.

9. (i) To study the relation between frequency and length of a given wire under constant tension using a sonometer.

(ii) To study the relation between the length of a given wire and tension, for constant frequency, using a sonometer.

10. To find the speed of sound in air, at room temperature, using a resonance tube, by observing the two resonance positions.

Note: The above practicals may be carried out in an experiential manner rather than recording observations.

Prescribed Books:

1 Physics Part-I, Textbook for Class XI, Published by NCERT

2 Physics Part-II, Textbook for Class XI, Published by NCERT

3 The list of other related books and manuals brought out by NCERT (consider multimedia also).

PHYSICS (Code No. 042)

QUESTION PAPER DESIGN

CLASS - XI (2016-17)

Time: 3 hrs. **Max Marks: 70**

S.No	Typology of Questions	Very Short Answer (VSA) (1 mark)	Short Answer-I (SA) (2 marks)	Short Answer-II (SA-II) (3 marks)	Value based question (4 marks)	Long Answer (LA) (5 marks)	Total Marks	% Weightage
1.	Remembering- (Knowledge based Simple recall questions, to know specific facts, terms,concepts, principles, or theories, identify, define, or recite information)	2	1	1	-	-	7	10%
2.	Understanding- (Comprehension -to be familiar with meaning and to understand conceptually, interpret, compare, contrast, explain, paraphrase information)	-	2	4	-	1	21	30%
3.	**Application -** (Use abstract - information in concrete situation, to apply knowledge to new situations, Use given	-	2	4	-	1	21	30%

	content to interpret a situation, provide an example, or solve a problem)							
4.	**Higher Order Thinking Skills - (Analysis Er Synthesis-** Classify, compare, contrast, or differentiate between different pieces of information, Organize and/or integrate unique pieces of information from a variety of sources)	2	-	1	-	1	10	14%
5.	**Evaluation -** (Appraise, judge, and/or justify the value or worth of a decision or outcome, or to predict outcomes based on values)	1	-	2	1	-	11	16%
	Total	**5x1=5**	**5x2=10**	**12x3=36**	**1x4=4**	**3x5=15**	**70(26)**	**100%**

Question Wise Break Up

Type of Question	Mark per Question	Total No. of Questions	Total Marks
VSA	1	5	05
SA-I	2	5	10
SA-II	3	12	36
VBQ	4	1	04
LA	5	3	15
Total		**26**	**70**

1.Internal Choice: There is no overall choice in the paper. However, there is an internal choice in one question of 2 marks weightage, one question of 3 marks weightage and all the three questions of 5 marks weightage.

1. 2.The above template is only a sample. Suitable internal variations may be made for generating similar templates keeping the overall weightage to different form of questions and typology of questions same.

CLASS XII (2016-17)
(THEORY)

Time: 3 hrs. **Max Marks: 70**

		No. of	Marks

		Periods	
Unit-I	**Electrostatics**	22	15
	Chapter-1: Electric Charges and Fields		
	Chapter-2: Electrostatic Potential and Capacitance		
Unit-II	**Current Electricity**	20	
	Chapter-3: Current Electricity		
Unit-III	**Magnetic Effects of Current and Magnetism**	22	16
	Chapter-4: Moving Charges and Magnetism		
	Chapter-5: Magnetism and Matter		
Unit-IV	**Electromagnetic Induction and Alternating Currents**	20	
	Chapter-6: Electromagnetic Induction		
	Chapter-7: Alternating Current		
Unit-V	**Electromagnetic Waves**	04	17
	Chapter-8: Electromagnetic Waves		
Unit-VI	**Optics**	25	
	Chapter-9: Ray Optics and Optical Instruments		
	Chapter-10: Wave Optics		
Unit-VII	**Dual Nature of Radiation and Matter**	08	10
	Chapter-11: Mechanical Properties of Solids		
Unit-VIII	**Atoms and Nuclei**	14	
	Chapter-12: Atoms		
	Chapter-13: Nuclei		
Unit-IX	**Electronic Devices**	15	12
	Chapter—14: Semiconductor Electronics: Materials,Devices and Simple Circuits		
Unit-X	Communication Systems		
	Chapter-15: Communication Systems	10	
Total		160	70

Unit I: Electrostatics **22 Periods**

Chapter—1: Electric Charges and Fields

Electric Charges; Conservation of charge; Coulomb's law-force between two point charges; forces between multiple charges; superposition principle and continuous charge distribution.

Electric field, electric field due to a point charge, electric field lines, electric dipole, electric field due to a dipole, torque on a dipole in uniform electric fleld.

Electric flux, statement of Gauss's theorem and its applications to find field due to infinitely long straight wire, uniformly charged infinite plane sheet and uniformly charged thin spherical shell (field inside and outside).

Chapter-2: Electrostatic Potential and Capacitance

Electric potential; potential difference; electric potential due to a point charge, a dipole and system of charges; equipotential surfaces; electrical potential energy of a system of two point charges and of electric dipole in an electrostatic field.

Conductors and insulators; free charges and bound charges inside a conductor. Dielectrics and electric polarisation; capacitors and capacitance; combination of capacitors in series and in parallel; capacitance of a parallel plate capacitor with and without dielectric medium between the plates; energy stored in a capacitor.

Unit II: Current Electricity **22 Periods**

Chapter-3: Current Electricity

Electric current; flow of electric charges in a metallic conductor; drift velocity; mobility and their relation with electric current; Ohm's law; electrical resistance; V-I characteristics (linear and non-linear), electrical energy and power; electrical resistivity and conductivity; Carbon resistors; colour code for carbon resistors; series and parallel combinations of resistors; temperature dependence of resistance.

Internal resistance of a cell; potential difference and emf of a cell; combination of cells in series and in parallel; Kirchhoff's laws and simple applications; Wheatstone bridge, metre bridge.

Potentiometer - principle and its applications to measure potential difference and for comparing EMF of two cells; measurement of internal resistance of a cell. Magnetic Effects of Current and

Unit III: Magnetism **22 Periods**

Chapter-4: Moving Charges and Magetism

Concept of magnetic field, Oersted‘s experiment.

Biot - Savart law and its application to current carrying circular loop.

Ampere's law and its applications to infinitely long straight wire. Straight and toroidal solenoids (only qualitative treatment); force on a moving charge in uniform magnetic and electric fields; Cyclotron.

Force on a current-carrying conductor in a uniform magnetic field; force between two parallel current-carrying conductors-definition of ampere, torque experienced by a current loop in uniform magnetic field; moving coil galvanometer-its current sensitivity and conversion to ammeter and voltmeter.

Chapter-5: Magnetism and Matter

Current loop as a magnetic dipole and its magnetic dipole moment; magnetic dipole moment of a revolving electron; magnetic field intensity due to a magnetic dipole (bar magnet) along its axis and perpendicular to its axis; torque on a magnetic dipole (bar magnet) in a uniform magnetic field; bar magnet as an equivalent solenoid; magnetic field lines; earth's magnetic field and magnetic elements.

Para-, dia- and ferro - magnetic substances, with examples. Electromagnets and factors affecting their strengths; permanent magnets.

Unit IV: Electromagnetic Induction and Alternating Currents **20 Periods**

Chapter-6: Electromagnetic Induction

Electromagnetic induction; Faraday's laws, induced EMF and current; Lenz's Law, Eddy currents.

Self and mutual induction.

Chapter-7: Alternating Current

Alternating currents, peak and RMS value of alternating current/voltage; reactance and impedance; LC oscillations (qualitative treatment only); LCR series circuit; resonance; power in AC circuits, power factor; wattless current. AC generator and transformer.

Unit V: Electromagnetic waves **04 Periods**

Chapter-8: Electromagnetic Waves

Basic idea of displacement current, Electromagnetic waves, their characteristics, their Transverse nature (qualitative ideas only).

Electromagnetic spectrum (radio waves, microwaves, infrared, visible, ultraviolet, X~rays, gamma rays) including elementary facts about their uses.

Unit VI: Optics **25 Periods**

Chapter-9: Ray Optics and Optical Instruments

Ray Optics: Reflection of light; spherical mirrors; mirror formula; refraction of light; total internal reflection and its applications; optical; fibres; refraction at spherical surfaces; lenses; thin lens formula; lensmaker's formula; magnification, power of a lens; combination of thin lenses in contact; refraction and dispersion of light through a prism.

Scattering of light - blue colour of sky and reddish apprearance of the sun at sunrise and sunset.

Optical instruments: Microscopes and astronomical telescopes (reflecting and refracting) and their magnifying powers.

Chapter-10: Wave Optics

Wave optics: Wave front and Huygen's principle; reflection and refraction of plane wave at a plane surface using wave fronts. Proof of laws of reflection and refraction using Huygen's principle. Interference; Young‘s double slit experiment and expression for fringe width, coherent sources and sustained interference of light; diffraction due to a single slit; width of central maximum; resolving power of microscope and astronomical telescope, polarisation; plane polarised light; Brewster's law; uses of plane polarised light and Polaroids.

Unit VII: Dual Nature of Radiation and Matter **08 Periods**

Chapter-11: Dual Nature of Radiation and Matter

Dual nature of radiation; Photoelectric effect; Hertz and Lenard's observations; Einstein's photoelectric equation-particle nature of light.

Matter waves-wave nature of particles; de-Broglie relation; Davisson-Germer experiment (experimental details should be omitted; only conclusion should be explained).

Unit VIII: Atoms and Nuclei **14 Periods**

Chapter-12: Atoms

Alpha-particle scattering experiment; Rutherford's model of atom; Bohr model, energy levels, hydrogen spectrum.

Chapter-13: Nuclei

Composition and size of nucleus; Radioactivity; alpha, beta and gamma particles/rays and their properties; radioactive decay law.

Mass-energy relation; mass defect; binding energy per nucleon and its variation with mass number; nuclear fission; nuclear fusion.

Unit IX: Electronic Devices **15 Periods**

Chapter-14: Semiconductor Electronics: Materials, Devices and Simple Circuits

Energy bands in conductors; semiconductors and insulators (qualitative ideas only)

Semiconductor diode - I-V characteristics in forward and reverse bias; diode as a rectifier; Special purpose p-n junction diodes: LED, photodiode, solar cell and Zener diode and their characteristics; Zener diode as a voltage regulator.

Junction transistor; transistor action; characteristics of a transistor and transistor as an amplifier (common emitter configuration); basic idea of analog and digital; signals Logic gates (OR, AND, NOT, NAND and NOR).

Unit X: Communication Systems **10 Periods**

Chapter-15: Communication Systems

Elements of a communication system (block diagram only); bandwidth of signals (speech, TV and digital data); bandwidth of transmission medium. Propagation of electromagnetic waves in the atmosphere, sky and space wave propagation, satellite communication. Need for modulation, amplitude modulation.

PRACTICALS **(Total Periods 60)**

The record to be submitted by the students at the time of their annual examination has to include:

- Record of at least 15 Experiments [with a minimum of 6 from each section], to be performed by the students.
- Record of at least 5 Activities [with a minimum of 2 each from section A and section B], to be demonstrated by the teachers.
- The Report of the project to be carried out by the students. xxm

Evaluation Scheme

Time Allowed: Three hours **Max. Marks: 30**

Two experiments one from each section	8+8 Marks
Practical record (experiment and activities)	6 Marks
Investigatory Project	3 Marks
Viva on experiments, activities and project	5 Marks
Total	**30 Marks**

SECTION-A

Experiments

1. To determine resistance per cm of a given wire by plotting a graph for potential difference versus current.

2. To find resistance of a given wire using metre bridge and hence determine the resistivity (specific resistance) of its material.

3. To verify the laws of combination (series) of resistances using a metre bridge.

4. To verify the laws of combination (parallel) of resistances using a metre bridge.

5. To compare the EMF of two given primary cells using potentiometer.

6. To determine the internal resistance of given primary cell using potentiometer.

7. To determine resistance of a galvanometer by half-deflection method and to find its figure of merit.

8. To convert the given galvanometer (of known resistance and figure of merit) into a voltmeter of desired range and to verify the same.

9. To convert the given galvanometer (of known resistance and figure of merit) into an ammeter of desired range and to verify the same.

10. To find the frequency of AC mains with a sonometer.

Activities

(For the purpose of demonstration only)

1. To measure the resistance and impedance of an inductor with or without iron core.

2. To measure resistance, voltage (AC/DC), current (AC) and check continuity of a given circuit using multimeter.

3. To assemble a household circuit comprising three bulbs, three (on/off) switches, a fuse and a power source.

4. To assemble the components of a given electrical circuit.

5. To study the variation in potential drop with length of a wire for a steady current.

6. To draw the diagram of a given open circuit comprising at least a battery, resistor/rheostat, key,ammeter and voltmeter. Mark the components that are not connected in proper order and correct the circuit and also the circuit diagram.

SECTION-B

Experiments

1. To find the value of v for different values of u in case of a concave mirror and to find the focal length.

2. To find the focal length of a convex mirror, using a convex lens.

3. To find the focal length of a convex lens by plotting graphs between u and v or between 1/u and 1/v.

4. To find the focal length of a concave lens, using a convex lens.

5. To determine angle of minimum deviation for a given prism by plotting a graph between angle of incidence and angle of deviation.

6. To determine refractive index of a glass slab using a travelling microscope.

7. To find refractive index of a liquid by using convex lens and plane mirror.

8. To draw the I-V characteristic curve for a p-n junction in forward bias and reverse bias.

9. To draw the characteristic curve of a zener diode and to determine its reverse break down voltage.

10. To study the characteristic of a common - emitter npn or pnp transistor and to find out the values of current and voltage gains.

Activities

(For the purpose of demonstration only)

1. To identify a diode, an LED, a transistor, an IC, a resistor and a capacitor from a mixed collection of such items.

2. Use of multimeter to (i) identify base of transistor, (ii) distinguish between npn and pnp type transistors,(m) see the unidirectional flow of current in case of a diode and an LED, (iv) check whether a given electronic component (e.g., diode, transistor or IC) is in working order.

3. To study effect of intensity of light (by varying distance of the source) on an LDR.

4. To observe refraction and lateral deviation of a beam of light incident obliquely on a glass slab.

5. To observe polarization of light using two Polaroids.

6. To obsewe diffraction of light due to a thin slit.

7. To study the nature and size of the image formed by a (i) convex lens, (ii) concave mirror, on a screen by using a candle and a screen (for different distances of the candle from the lens/mirror).

8. To obtain a lens combination with the specified focal length by using two lenses from the given set of lenses.

Suggested Investigatory Projects

1. To study various factors on which the internal resistance/EMF of a cell depends.

2. To study the variations in current flowing in a circuit containing an LDR because of a variation in

(a) the power of the incandescent lamp, used to ‘illuminate’ the LDR (keeping all the lamps at a fixed distance).

(b) the distance of a incandescent lamp (of fixed power) used to ‘illuminate’ the LDR.

3. To find the refractive indices of (a) water (b) oil (transparent) using a plane mirror, an equi convex lens (made from a glass of known refractive index) and an adjustable object needle.

4. To design an appropriate logic gate combination for a given truth table.

5. To investigate the relation between the ratio of (i) output and input voltage and (ii) number of turns in the secondary coil and primary coil of a self designed transformer.

6. To investigate the dependence of the angle of deviation on the angle of incidence using a hollow prism filled one by one, with different transparent fluids.

7. To estimate the charge induced on each one of the two identical styrofoam (or pith) balls suspended in a vertical plane by making use of Coulomb's law.

8. To set up a common base transistor circuit and to study its input and output characteristic and to calculate its current gain.

9. To study the factor on which the self inductance of a coil depends by observing the effect of this coil,when put in series with a resistor/(bulb) in a circuit fed up by an A.C. source of adjustable frequency.

10. To construct a switch using a transistor and to draw the graph between the input and output voltage and mark the cut-off, saturation and active regions.

11. To study the earth's magnetic field using a tangent galvanometer.

Practical Examination for Visually Impaired Students of Classes XI and XII

Evaluation Scheme

Time Allowed: Two hours **Max. Marks: 30**

IdentificationIFamiliarity with the apparatus	5 Marks
Written test (based on given/prescribed practicals)	10 Marks
Practical Record	5 Marks
Viva	10 Marks
Total	**30 Marks**

General Guidelines

- The practical examination will be of two hour duration.
- A separate list of ten experiments is included here.
- The written examination in practicals for these students will be conducted at the time of practical examination of all other students.
- The written test will be of 30 minutes duration.
- The question paper given to the students should be legibly typed. It should contain a total of 15 practical skill based very short answer type questions. A student would be required to answer any 10 questions.
- A writer may be allowed to such students as per CBSE examination rules.
- All questions included in the question papers should be related to the listed practicals. Every question should require about two minutes to be answered.
- These students are also required to maintain a practical file. A student is expected to record at least five of the listed experiments as per the specific instructions for each subject. These practicals should be duly checked and signed by the internal examiner.
- The format of writing any experiment in the practical file should include aim, apparatus required,simple theory, procedure, related practical skills, precautions etc.
- Questions may be generated jointly by the external/internal examiners and used for assessment.
- The viva questions may include questions based on basic theory/principle/concept, apparatus/materials/chemicals required, procedure, precautions, sources of error etc.

Class XII

A. Items for Identification! familiarity with the apparatus for assessment in practicals (All experiments)

Meter scale, general shape of the voltmeter/ammeter, battery/power supply, connecting wires,standard resistances, connecting wires, voltmeter/ammeter, meter bridge, screw gauge, jockey Galvanometer, Resistance Box, standard Resistance, connecting wires, Potentiometer, jockey,Galvanometer, Lechlanche cell, Daniell cell (simple distinction between the two vis-a-vis their outer (glass and copper) containers), rheostat connecting wires, Galvanometer, resistance box, Plug-in and tapping keys, connecting wires battery/power supply, Diode, Transistor, IC, Resistor (Wire-wound or carbon ones with two wires connected to two ends), capacitors (one or two types), Inductors, Simple electric/electronic bell, battery/power supply, Plug-in and tapping keys, Convex lens, concave lens,convex mirror, concave mirror, Core/hollow wooden cylinder, insulated wire, ferromagnetic rod,Transformer core, insulated wire.

B. List of Practicals

1. To determine the resistance per cm of a given wire by plotting a graph between voltage and current.
2. To verify the laws of combination (series/parallel combination) of resistances by ohm's law.
3. To find the resistance of a given wire using a meter bridge and hence determine the specific resistance (resistivity) of its material.
4. To compare the e.m.f of two given primary cells using a potentiometer.
5. To determine the resistance of a galvanometer by half deflection method.
6. To identify a

(i) diode, transistor and IC

(ii) resistor, capacitor and inductor, from a mixed collection of such items.

7. To understand the principle of (i) a NOT gate (ii) an OR gate (m)an AND gate and to make their equivalent circuits using a bell and cells/battery and keys /switches.
8. To observe the difference between

(i) a convex lens and a concave lens

(ii) a convex mirror and a concave mirror and to estimate the likely difference between the power of two given convex / concave lenses.

9. To design an inductor coil and to know the effect of

(i) change in the number of turns

(ii) introduction of ferromagnetic material as its core material on the inductance of the coil.

10. To design a (i) step up (ii) step down transformer on a given core and know the relation between its input and output voltages.

Note: The above practicals may be carried out in an experiential manner rather than recording observations.

Prescribed Books:

1 Physics, Class XI, Part -I and II, Published by NCERT.

2 Physics, Class XII, Part -I and ll, Published by NCERT.

3 The list of other related books and manuals brought out by NCERT (consider multimedia also).

PHYSICS (Code No. 042)
QUESTION PAPER DESIGN
CLASS - XII (2016-11)

Time 3 hours **Max. Marks: 30**

S.No	Typology of Questions	Very Short Answer (VSA) (1 mark)	Short Answer-I (SA) (2 marks)	Short Answer-II (SA-II) (3 marks)	Value based question (4 marks)	Long Answer (LA) (5 marks)	Total Marks	% Weightage
	Remembering-(Knowledge based							

1.	Simple recall questions, to know specific facts, terms,concepts, principles, or theories, identify, define, or recite information)	2	1	1	-	-	7	10%
2.	**Understanding- (Comprehension** -to be familiar with meaning and to understand conceptually, interpret, compare, contrast, explain, paraphrase information)	-	2	4	-	1	21	30%
3.	**Application -** (Use abstract - information in concrete situation, to apply knowledge to new situations, Use given content to interpret a situation, provide an example, or solve a problem)	-	2	4	-	1	21	30%
4.	**Higher Order Thinking Skills - (Analysis Er Synthesis-** Classify, compare, contrast, or differentiate between different pieces of information, Organize and/or integrate unique pieces of information from a variety of sources)	2	-	1	-	1	10	14%
5.	**Evaluation -** (Appraise, judge, and/or justify the value or worth of a decision or outcome, or to predict outcomes based on values)	1	-	2	1	-	11	16%
	Total	**5x1=5**	**5x2=10**	**12x3=36**	**1x4=4**	**3x5=15**	**70(26)**	**100%**

Question Wise Break Up

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1.Internal Choice: There is no overall choice in the paper. However, there is an internal choice in one question of 2 marks weightage, one question of 3 marks weightage and all the three questions of 5 marks weightage.

2. The above template is only a sample. Suitable internal variations may be made for generating similar templates keeping the overall weightage to different form of questions and typology of questions same.

Fluids in motion and Energy Conservation

Introduction

In physics, fluid dynamics is a sub discipline of fluid mechanics that deals with fluid flow— the natural science of fluids (liquids and gases) in motion. It has several sub disciplines

itself, including aerodynamics (the study of air and other gases in motion) and hydrodynamics (the study of liquids in motion). Fluid dynamics has a wide range of

applications, including calculating forces and moments on aircraft, determining the mass flow rate of petroleum through pipelines, predicting weather pat erns, understanding nebulae in interstel ar space and model ing fission weapon detonation. Some of its principles are even used in traffic engineering, where traffic is treated as a continuous fluid, and crowd dynamics.

For the fluid in stream line motion, total energy containing three components kinetic energy, potential energy and pressure energy is constant.

Energy remains consened as long as there is no turbulence.

LEARNING OUTCOMES-

The learner

1. Studies dependence of speed of liquid flow on cross sectional area of the tube,itsrange of efflux.

2. Understands the concept of energy conservation.

3. Understands the lift of aeroplane and its controlled motion.

4. Understands the aerodynamical y designed shape of vehicles.

5. Applies the Bernovllis theorem in different situations.

CONCEPTUAL UNDERSTANDING

Fluids can have a streamlined flow in Ideal situations. In streamlined flow, the conservation principles in Physics **should be satisfied.**

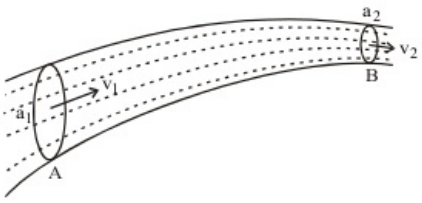
The two fundamental conservation with regard to moving liquids are

i) Volume Conservation – Continuity Equation

ii) Energy Conservation - Bernoul i's theorem

An ideal fluid/liquid can have Laminar flow, Non-viscous and irrotational character. Equation of continuity

For an incompressible, non-viscous liquid in streamline flow, the product of cross sectional area(a) of the tube and the velocity (v) of the liquid through that cross section is constant throughout the flow i.e. av = constant. "av" refers to the rate of flow.



If a_1 , a_2 are the area of cross section of the tube at A and B, v_1 and v_2 are the Velocity of the liquid at A and B.

ℓ_1 , ℓ_2 are the density of liquid at A & B.

Mass of the liquid enteringat A = $a_1 v_1 \ell_1$

Mass of the liquid leavingat B = $a_2 v_2 \ell_2$

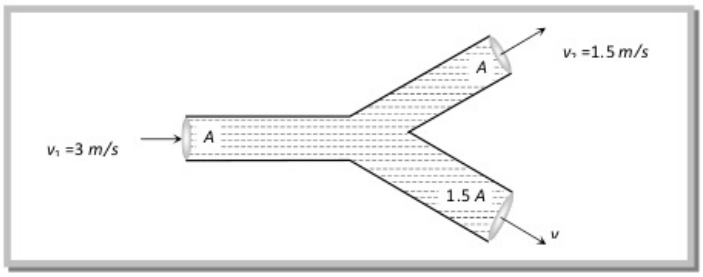
No liquid can remain in the tube and the flow is steady and the liquid is incompressible.

Therefore, $a_1 v_1 \ell_1 = a_2 v_2 \ell_2$

$\ell_1 = \ell_2$

$a_1 v_2 = a_2 v_2 l_2$ $\rightarrow$ av = constant.

Problem 1. An incompressible liquid flows through a horizontal tube as shown in the following fig. Then the velocity v of the fluid is



(a) 3.0 m/s (b) 1.5 m/s (c) 1.0 m/s (d) 2.25 m/s

Solution : (c) If the liquid is incompressible then mass of liquid entering through left end, should be equal to mass of liquid coming out from the right end.

$$\therefore M = m_1 + m_2 \Rightarrow Av_1 = Av_2 + 1.5A.v \Rightarrow A \times 3 = A \times 1.5 + 1.5A.v \Rightarrow v = 1\,m/s$$

Problem 2. Water enters through end A with speed v_1 and leaves through end B with speed v_2 of a cylindrical tube AB. The tube is always completely fil ed with water. In case I tube is horizontal and in case II it is vertical with end A upwards and in case III it is vertical with end B upwards. We have $v_1 = v_2$ for

(a) Case I (b) Case II (c) Case III (d) Each case

Solution : (d) This happens in accordance with equation of continuity and this equation was derived on the principle of conservation of mass and it is true in every case, either tube remain horizontal or vertical.

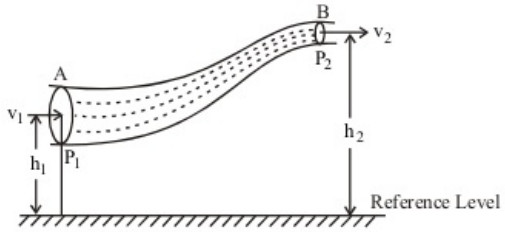
Bernoulli's Theorem

For an incompressible and non-viscous liquid in streamline flow, the total energy per unit

mass remains same at every cross-section of the flow. Total energy is the sum of pressure

energy, potential energy and kinetic energy.

Proof : Let P_1 , V_1 , a_1 are pressure, velocity of the liquid and area of cross-section of the pipe at A and P_2 , V_2 , a_2 are the corresponding quantities at B respectively.



h_1 and h_2 are heights of the ends A & B from a reference level.

As the liquid is flowing from A to B, $P_1 > P_2$

By equation of continuity, $a_1 V_1 = a_2 V_2 = aV$ (say)

Work done/second on the liquid at A = Force × displacement = $P_1 a_1 V_1$

Work done/s on the liquid at B = $P_2 a_2 V_2$

Net work done/s on the liquid = $P_1 a_1 V_1 - P_2 a_2 V_2 = P_1 V - P_2 V$

Change in K.E of the liquid = $mV_2^2 - m V_1^2$ [$V_2 > V_1$ $a_2 < a_1$]

Change in P.E of the liquid = $mgh_2 - mgh_1$

According to work-energy theorem, Work done = Change in energy

$P_1V - P_2V = mV_2^2 - mV_1^2 + mgh_2 - mgh_1$

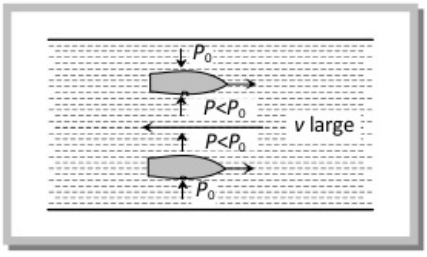
$P_1V + mgh_1 + mV_1^2 = P_2V + mgh_2 + m V_2^2$

Þ $PV + mgh + mV^2$ = constant Þ $(P/\rho) + gh + V^2$ = constant

Where (P/ρ) is cal ed pressure energy/unit mass, gh is cal ed potential energy/unit mass and V^2 is cal ed K.E/unit mass.

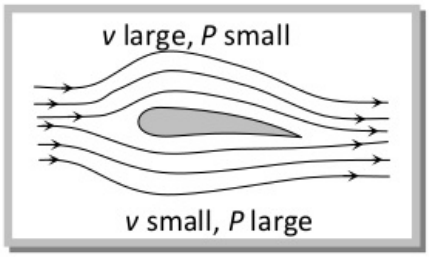
Applications of Bernoulli's Theorem

(i) **Attraction between two closely parallel moving boats (or buses) :** When two boats or buses move side by side in the same direction, the water (or air) in the region between them moves faster than that on the remote sides.Consequently in accordance with *Bernoulli'sprinciple* the pressure between them is reduced and hence due to pressure difference they are pulled towards each other creating the so called attraction.

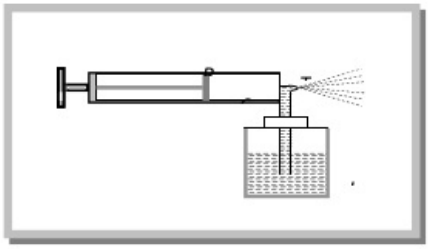


(ii) **Working of an aeroplane :** This is also based on Bernoulli's principle. The wings of the aeroplane are of the shape as shown in fig. Due to this specific shape of wings when the aeroplane runs, air passes at higher speed over it as compared to its lower surface. This difference of air speeds above and below the wings, in accordance with Bernoulli's

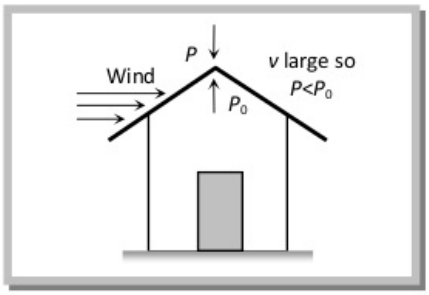
principle, creates a pressure difference, due to which an upward force called 'dynamic lift' (= pressure difference × area of wing) acts on the plane. If this force becomes greater than the weight of the plane, the plane will rise up.



(iii) **Action of atomiser:** The action of carburetor, paint-gun, scent-spray or insect-sprayer is based on Bernoulli's principle. In al these, by means of motion of a piston *P* in a cylinder C,high speed air is passed over a tube *T* dipped in liquid L to be sprayed. High speed air creates low pressure over the tube due to which liquid (paint, scent, insecticide or petrol) rises in it and is then blown off in very smal droplets with expelled air.



(iv) **Blowing off roofs by wind storms :** During a tornado or hurricane, when a high speed wind blows over a straw or tin roof, it creates a low pressure (P) in accordance with Bernoul i's principle.

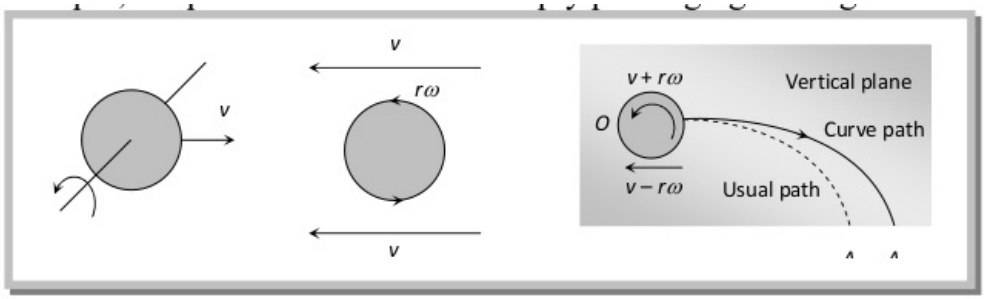


However, the pressure below the roof (i.e., inside the room) is stil atmospheric ($=P_0$). So due to this difference of pressure the roof is lifted up and is then blown off by the wind.

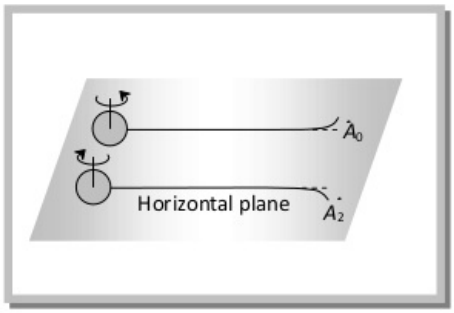
(v) **Magnus effect** : When a spinning bal is thrown, it deviates from its usual path in flight. This effect is cal ed Magnus effect and plays as important role in tennis, cricket and soccer, etc. as by applying appropriate spin the moving bal can be made to curve in any desired direction.

If a bal is moving from left to right and also spinning about a horizontal axis perpendicular to the direction of motion as shown in fig. then relative to the bal , air will be moving from right to left.

The resultant velocity of air above the bal will be (v+r ω) while below it (v-r ω). So in accordance with Bernoul i's principle pressure above the bal will be less than below it. Due to this difference of pressure an upward force will act on the bal and hence the bal will deviate from its usual path OA_0 and will hit the ground at A_1 following the path OA_1 i.e., if a ball is thrown with back-spin, the pitch will curve less sharply prolonging the flight.



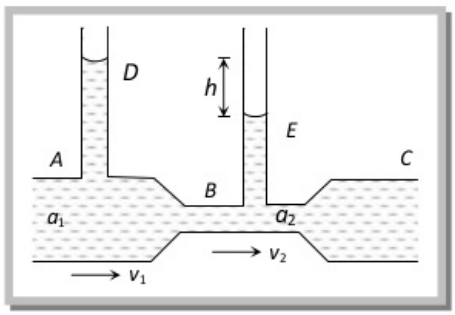
Similarly if the spin is clockwise i.e., the ball is thrown with top-spin, the force due to pressure difference will act in the direction of gravity and so the pitch will curve more sharply shortening the flight.



Furthermore, if the bal is spinning about a vertical axis, the curving will be sideways as shown in producing the so called out swing or in swing.

(vi)**Venturimeter** : It is a device based on Bernoulli's theorem used for measuring the rate of flow of liquid through pipes.

It consists of two identical coaxial tubes A and C connected by a narrow co-axial tube B. Two vertical tubes D and E are mounted on the tubes A and B to measure the pressure of the following liquid.



When the liquid flows in the tube ABC, the velocity of flow in part B will be larger than in the tube A or C.So the pressure in part B will be less than that in tube Aor C. By measuring the pressure difference between A and B, the rate of flow of the liquid in the tube can be calculated.

Let a_1 ,a_2 = area of cross section of tube A and B respectively

v , v2 = Velocity of flow of liquid through A and B respectively

P_1 , P_2 = Liquid pressure at A and B respectively

$P_1 - P_2$ hρg . ....(i) [ρ = density of flowing liquid]

From Bernoulli's theorem for horizontal flow of liquid

$$P_1 + \frac{1}{2}\rho v_1^2 = P_2 + \frac{1}{2}\rho v_2^2$$

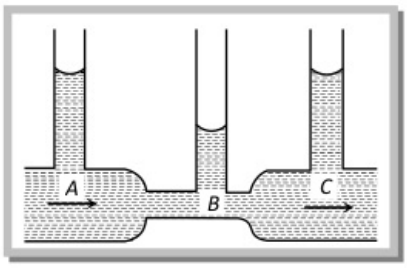
$$P_1 - P_2 = \frac{1}{2}\rho(v_2^2 - v_1^2) \qquad \text{.....(ii)}$$

From (i) and (ii) $h\rho g = \frac{1}{2}\rho(v_2^2 - v_1^2) = \frac{1}{2}\rho\left[\frac{V^2}{a_2^2} - \frac{V^2}{a_1^2}\right]$ [As $V = a_1 v_1 = a_2 v_2$]

$$\therefore V^2 = \frac{2a_1^2 a_2^2 hg}{a_1^2 - a_2^2} \text{ or } V = a_1 a_2 \sqrt{\frac{2hg}{a_1^2 - a_2^2}}$$

Problem 3. In the following fig. is shown the flow of liquid through a horizontal pipe.

Three tubes A, B and Care connected to the pipe. The radii of the tubes A, B and C at the junction are respectively 2 cm, 1 cm and 2 cm. It can be said that the



(a) Height of the liquid in the tube A is maximum

(b) Height of the liquid in the tubes A and B is the same

(c) Height of the liquid in all the three tubes is the same

(d) Height of the liquid in the tubes A and C is the same

Solution : (d) As cross-section areas of both the tubes A and C are same and tube is horizontal. Hence according to equation of continuity $v_A = v_C$ and therefore according to Bernoul i's theorem $P_A = P_C$ i.e. height of liquid is same in both the tubes A and C.

Problem 4. A liquid is kept in a cylindrical vessel which is being rotated about a vertical axis through the centre of the circular base. If the radius of the vessel is r and angular velocity of rotation is ω, then the difference in the heights of the liquid at the centre of the vessel and the edge is

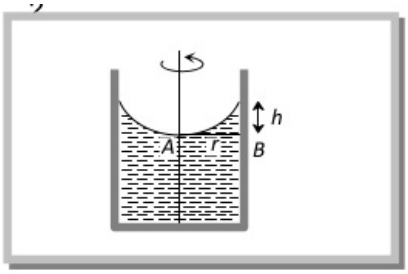
(a) $\frac{r\omega}{2g}$ (b) $\frac{r^2\omega^2}{2g}$ (c) $\sqrt{2gr\omega}$ (d) $\frac{\omega^2}{2gr^2}$

Solution : (b) From Bernoulli's theorem, $P_A + \frac{1}{2}dv_A^2 + dgh_A = P_B + \frac{1}{2}dv_B^2 + dgh_B$

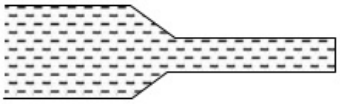
Here, $h_A = h_B \therefore P_A + \frac{1}{2}dv_A^2 = P_B + \frac{1}{2}dv_B^2 \Rightarrow P_A - P_B = \frac{1}{2}d[v_B^2 - v_A^2]$

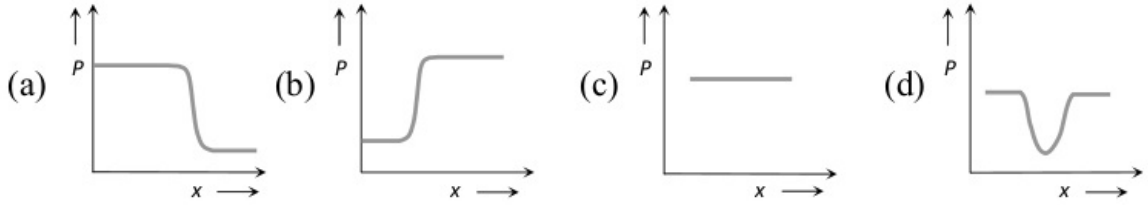
Now, $v_A = 0, v_B = r\omega$ and $P_A - P_B = hdg$

$$\therefore hdg = \frac{1}{2}dr^2\omega^2 \text{ or } h = \frac{r^2\omega^2}{2g}$$



Problem 5. Water flows through a frictionless duct with a cross-section varying as shown infig. Pressure p at points along the axis is represented by





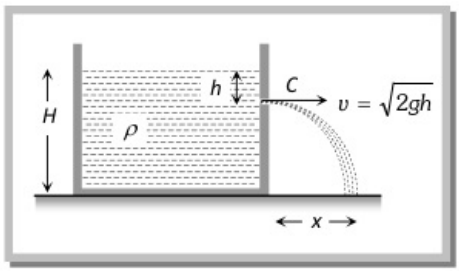
Solution : (a) When cross section of duct decreases the velocity of water increases and in

accordance with Bernoul i's theorem the pressure decreases at that place.

Velocity of Efflux.

If a liquid is fil ed in a vessel up to height H and a hole is made at a depth h below the free surface of the liquid as shown in fig. then taking the level of hole as reference level (i.e., zero point of potential energy) and applying Bernoulli's principle to the liquid just inside and outside the hole (assuming the liquid to be at rest inside) we get

$$\therefore \qquad (P_0 + h\rho g) + 0 = P_0 + \frac{1}{2}\rho v^2 \text{ or } v = \sqrt{2gh}$$



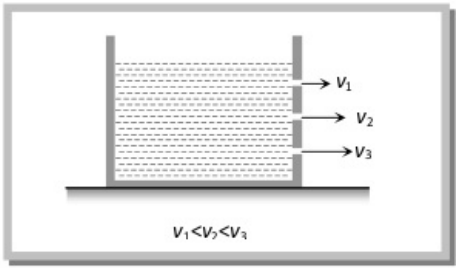
Which is same as the speed that an object would acquire in fal ing from rest through a distance h and is cal ed velocity of efflux or velocity of flow.

This result was first given by Torricel i so this is known as Torricel i's theorem.

(i) The velocity of efflux is independent of the nature of liquid, quantity of liquid in the vessel and the area of orifice.

(ii) Greater is the distance of the hole from the free surface of liquid greater will be the velocity of efflux

$[i.e., v \propto \sqrt{h}]$



(iii) As the vertical velocity of liquid at the orifice is zero and it is at a height (H-h) from the base, the time taken by the liquid to reach the base-level $t = \sqrt{\frac{2(H-h)}{g}}$

Problem 6. A cylinder of height 20 m is completely fil ed with water. The velocity of efflux of water (in m/s) through a smal hole on the side wal of the cylinder near its bottom is

(a) 10 (b) 20 (c) 25.5 (d) 5

Solution : (b) $v = \sqrt{2gh} = \sqrt{2\times 10\times 20} = 20 m/s$

Problem 7. There is a hole in the bot om of tank having water. If total pressure at bottom is 3 atm (1 atm= 10^5N/m2) then the velocity of water flowing from hole is

(a) $\sqrt{400}\, m/s$ (b) $\sqrt{600}\, m/s$ (c) $\sqrt{60}\, m/s$ (d) None of these

Solution : (b) Pressure at the bot om of tank $P = h\rho g = 3\times 10^5 \frac{N}{m^2}$ and velocity of water

$v = \sqrt{2gh}$

$\therefore v = \sqrt{\frac{2P}{\rho}} = \sqrt{\frac{2\times 3\times 10^5}{10^3}} = \sqrt{600}\, m/s$

Problem 8. A large open tank has two holes in the wal . One is a square hole of side L at a depth y from the top and the other is a circular hole of radius R at a depth 4y from the top. When the tank is completely fil ed with water the quantities of water flowing out per second from both the holes are the same. Then R is equal to

(a) $2\pi L$ (b) $\frac{L}{\sqrt{2\pi}}$ (c) L (d) $\frac{L}{2\pi}$

Solution : (b) Velocity of efflux when the hole is at depth $h, v = \sqrt{2gh}$

Rate of flow of water from square hole $Q_1 = a_1 v_1 = L^2\sqrt{2gy}$

Rate of flow of water from circular hole $Q_2 = a_2 v_2 = \pi R^2\sqrt{2g(4y)}$

and according to problem $Q_1 = Q_2 \Rightarrow L^2\sqrt{2gy} = \pi R^2\sqrt{2g(4y)} \Rightarrow R = \frac{L}{\sqrt{2\pi}}$

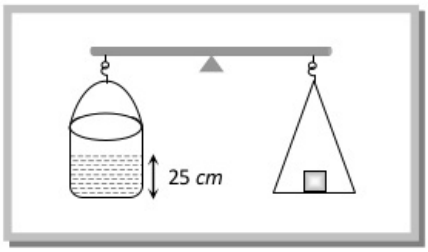
Problem 9. There is a hole of area A at the bottom of cylindrical vessel. Water is filled up to a height h and water flows

out in *t* second. If water is filled to a height 4h, it will flow out in time equal to

(a) t (b) 4t (c) 2 t (d) t/4

Solution : (c) Time required to emptied the tank $t = \frac{A}{A_0}\sqrt{\frac{2H}{g}} \Rightarrow \frac{t_2}{t_1} = \sqrt{\frac{H_2}{H_1}} = \sqrt{\frac{4h}{h}} = 2 \ \therefore \ t_2 = 2t$

Problem 10. A cylinder containing water up to a height of 25 cm has a hole of cross-section ¼ cm^2 in its bottom. It is counterpoised in a balance. What is the initial change in the balancing weight when water begins to flow out



(a) Increase of 12.5 gm-wt

(b) Increase of 6.25 gm-wt

(c) Decrease of 12.5 gm-wt

(d) Decrease of 6.25 gm-wt

Solution : (c) Let A = The area of cross section of the hole, v = Initial velocity of efflux, d =

Density of water, Initial volume of water flowing out per second = Av

Initial mass of water flowing out per second =Avd

Rate of change of momentum = Adv^2 ▫ Initial downward force on the out flowing water = Adv^2

So equal amount of reaction acts upwards on the cylinder.

$\therefore$ Initial upward reaction $= Adv^2$ [As $v = \sqrt{2gh}$]

$\therefore$ Initial decrease in weight $= Ad(2gh) = 2Adgh = 2 \times \left(\frac{1}{4}\right) \times 1 \times 980 \times 25 = 12.5 \, gm\text{-}wt.$

Problem 11. A cylindrical tank has a hole of 1 cm2 in its bottom. If the water is allowed to flow into the tank from a tube above it at the rate of 70 cm3/sec. then the maximum height up to which water can rise in the tank is

(a) 2.5 cm (b) 5 cm (c) 10 cm (d) 0.25 cm

Solution : (a) The height of water in the tank becomes maximum when the volume of water flowing into the tank per second becomes equal to the volume flowing out per second.

Volume of water flowing out per second $= Av = A\sqrt{2gh}$

and volume of water flowing in per second $= 70 \, cm^3 / \sec.$

$\therefore A\sqrt{2gh} = 70 \Rightarrow 1 \times \sqrt{2gh} = 70 \Rightarrow 1 \times \sqrt{2 \times 980 \times h} = 70 \ \therefore h = \frac{4900}{1960} = 2.5 \, cm.$

Activity 1

Discuss the Applicability of incompressible flow equation to flow of gases in the groups and write the Group observation

Bernoulli's equation is valid for the flow of gases: as long as there is no transfer of kinetic or potential energy from the gas flow to the compression or expansion of the gas. If both the gas pressure and volume change simultaneously, then work will be done on or by the gas. In this case, Bernoulli's equation – in its incompressible flow form – cannot be assumed to be valid. However, if the gas process is entirely isobaric, or isochoric, then no work is done on or by the gas, (so the simple energy balance is not upset). According to the gas law, an isobaric or isochoric process is ordinarily the only way to ensure constant density in a gas. Also the gas density will be proportional to the ratio of pressure and absolute temperature, however this ratio will vary upon compression or expansion, no matter what non-zero quantity of heat is added or removed. The only exception is if the net heat transfer is zero, as in a complete thermodynamic cycle, or in an individual isentropic (frictionless adiabatic) process, and even then this reversible process must be reversed, to restore the gas to the original pressure and specific volume, and thus density. Only then is the original, unmodified Bernoul i equation applicable. In this case the equation can be used if the flow speed of the gas is sufficiently below the speed of sound, such that the variation in density of the gas (due to this effect) along each streamline can be ignored. Adiabatic flow at less than Mach 0.3 is generally considered to be slow enough.

Activity 2

Discuss the application in Modern day to day life in the groups.

APPLICATIONS

Condensation visible over the upper surface of an Airbus A340 wing caused by the fal in temperature accompanying the fal in pressure, both due to acceleration of the air. In modern everyday life there are many observations that can be successfully explained by application of Bernoulli's principle, even though no real fluid is entirely inviscid and a small viscosity often has a large effect on the flow.

- Bernoulli's principle can be used to calculate the lift force on an airfoil, if the behaviour of the fluid flow in the vicinity of the foil is known. For example, if the air flowing past the top surface of an aircraft wing is moving faster

than the air flowing past the bottom surface, then Bernoulli's principle implies that the pressure on the surfaces of the wing will be lower above than below. This pressure difference results in an upwards lifting force. Whenever the distribution of speed past the top and bot om surfaces of a wing is known, the lift forces can be calculated (to a good approximation) using Bernoulli's equations.

- The carburetor used in many reciprocating engines contains a venturi to create a region of low pressure to draw fuel into the carburetor and mix it thoroughly with the incoming air. The low pressure in the throat of a venturi can be explained by Bernoulli's principle-in the narrow throat, the air is moving at its fastest speed and therefore it is at its lowest pressure.
- An injector on a steam locomotive (or static boiler).
- The pitot tube and static port on an aircraft are used to determine the airspeed of the aircraft. These two devices are connected to the airspeed indicator, which determines the dynamic pressure of the airflow past the aircraft. Dynamic pressure is the difference between stagnation pressure and static pressure. Bernoulli's principle is used to calibrate the airspeed indicator so that it displays the indicated airspeed appropriate to the dynamic pressure.
- The flow speed of a fluid can be measured using a device such as a Venturi meter or an orifice plate, which can be placed into a pipeline to reduce the diameter of the flow. For a horizontal device, the continuity equation shows that for an incompressible fluid, the reduction in diameter will cause an increase in the fluid flow speed. Subsequently Bernoulli's principle then shows that there must be a decrease in the pressure in the reduced diameter region. This phenomenon is known as the Venturi effect.
- The maximum possible drain rate for a tank with a hole or tap at the base can be calculated directly from Bernoul i's equation, and is found to be proportional to the square root of the height of the fluid in the tank. This is Torricelli's law, showing that Torricel i's law is compatible with Bernoulli's principle. Viscosity lowers this drain rate.This is reflected in the discharge coefficient, which is a function of the Reynolds number and the shape of the orifice.
- The Bernoulli grip relies on this principle to create a non-contact adhesive force between a surface and the gripper.

ACTIVITIE-3

Discuss the Misunderstandings about the generation of lift in the groups and ask them to penning down the points.

Many explanations for the generation of lift (on airfoils, propeller blades, etc.) can be found; some of these explanations can be misleading, and some are false. This has been a source of heated discussion over the years. In particular, there has been debate about whether lift is best explained by Bernoulli's principle or Newton's laws of motion. Modern writings agree that both Bernoulli's principle and Newton's laws are relevant and either can be used to correctly describe lift.

Several of these explanations use the Bernoulli principle to connect the flow kinematics to the flow-induced pressures. In cases of incorrect (or partially correct) explanations relying on the Bernoul i principle, the errors general y occur in the assumptions on the flow kinematics and how these are produced. It is not the Bernoulli principle itself that is questioned because this principle is wel established

ACTIVITY -4

Discuss the Misapplications of Bernoulli's principle in common classroom demonstrations in the groups and pen down the points

There are several common classroom demonstrations that are sometimes incorrectly explained using Bernoulli's principle.One involves holding a piece of paper horizontally so that it droops downward and then blowing over the top of it. As the demonstrator blows over the paper, the paper rises. It is then asserted that this is because "faster moving air has lower pressure".

One problem with this explanation can be seen by blowing along the bottom of the paper: were the deflection due simply to faster moving air one would expect the paper to deflect downward, but the paper deflects upward regardless of whether the faster moving air is on the top or the bottom.Another problem is that when the air leaves the demonstrator's mouth it has the same pressure as the surrounding air; the air does not have lower pressure

just because it is moving; in the demonstration, the static pressure of the air leaving the demonstrator's mouth is equal to the pressure of the surrounding air. A third problem is that it is false to make a connection between the flow on the two sides of the paper using Bernoulli's equation since the air above and below are dif erent flow fields and Bernoulli's principle only applies within a flow field.

As the wording of the principle can change its implications, stating the principle correctly is important. What Bernoulli's principle actually says is that within a flow of constant energy, when fluid flows through a region of lower pressure it speeds up and vice versa.Thus, Bernoulli's principle concerns itself with changes in speed and changes in pressure within a flow field. It cannot be used to compare different flow fields.

A correct explanation of why the paper rises would observe that the plume follows the curve of the paper and that a curved streamline will develop a pressure gradient perpendicular to the direction of flow, with the lower pressure on the inside of the curve. Bernoul i's principle predicts that the decrease in pressure is associated with an increase in speed, i.e. that as the air passes over the paper it speeds up and moves faster than it was moving when it left the demonstrator's mouth. But this is not apparent from the demonstration.

Other common classroom demonstrations, such as blowing between two suspended spheres, inflating a large bag, or suspending a bal in an airstream are sometimes explained in a similarly misleading manner by saying "faster moving air has lower pressure

CONCLUSICVE REMARKS-The study of fluid flow with the help of Bernoulli's theorem enables learner that in what way three component of energy change. And when does the forth component of energy e.g. heatenergy comes in to effect.(For turbulent flow, Limitation of Bernoulli theorem)

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Links

- ¬ Bernoulli equation calculator
- ¬Denver University – Bernoulli's equation and pressure measurement
- ¬Mil ersvil e University – Applications of Euler's equation
- ¬NASA – Beginner's guide to aerodynamics
- ¬Misinterpretations of Bernoulli's equation – Weltner and Ingelman-Sundberg

ELECTRICAL CAPACITANCE

Introduction

Capacitor or a condenser is an electrical device which is developed to store energy in the electric field. The study of the field due to an array to charges in a conductor evolved this

too. Fundamental understanding of this device has revolutionised the communication system as it builds a tuneable device. In this portion we are trying to understand the principle,

construction, the way the energy is stored, amount of energy stored and the ways and means to increase the same.

LEARNING OUTCOME-

After reading this topic learner will be able to –

1. Understand the various effect on capacitance of plate area, plate separation and medium.

2. Charging and discharging of capacitor.

3. Select the capacitor of optimum or suitable capacitance for a specific purpose.

4. Find the required value of capacitance in series and parallel combination of capacitors.

PRINCIPLE OF CAPACITOR

Bringing an uncharged earthed conductor near a charged conductor reduces the potential of the charged conductor thereby permit ing more charge storage and hence increasing the capacity.

Note : Two conductors some distance apart form a capacitor or condenser.

If conductors are plane : parallel plate capacitor

If spherical: Spherical capacitor.

If cylindrical: cylindrical capacitor.

CONCEPTUAL UNDERSTANDING

FACTORS AFFECTING THE VALUE OF CAPACITANCE :

1) Shape of the conductor.

2) Size (dimensions) of the conductor.

3) Nature of the medium in which the conductor is kept.

NOTE: The value of C does not depend on the nature of material of the capacitor.

S.I. UNIT

The standard unit to measure capacitance is farad (F)

1 farad= 1V X 1C

I.e when a charge of 1C raises the potential of the conductor through 1V the capacitance of the conductor is 1unit =1F.

Capacity of an isolated spherical conductor : When charge Q is given to a spherical conductor of radius R, then potential at the surface of sphere is

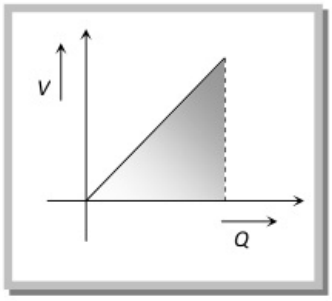
$$V = k.\frac{Q}{R} \qquad \left\{k = \frac{1}{4\pi\varepsilon_0}\right\}$$

$$\text{Hence it's capacity } C = \frac{Q}{V} = 4\pi\varepsilon_0 R \quad \Rightarrow \quad C = 4\pi\square_0 R = \frac{1}{9\times10^9}.R$$

$$\text{in C.G.S.} \qquad C = R$$

Note : If earth is assumed to be spherical having radius R = 6400 km.It's theoretical capacitance $C = \frac{1}{9\times10^9}\times6400\times10^3 = 711\,\mu F$. But for al practical purpose capacitance of earth is taken infinity.

Energy of a charged conductor : When a conductor is charged it's potential increases from 0 to V as shown in the graph; and work is done against the electric field. This work is stored as "electrostatic potential energy"



From graph : Work done = Area of graph $= \frac{1}{2}QV$

Hence potential energy $U = \frac{1}{2}QV$; By using $Q = CV$, we can write

$$U = \frac{1}{2}QV = \frac{1}{2}CV^2 = \frac{Q^2}{2C}$$

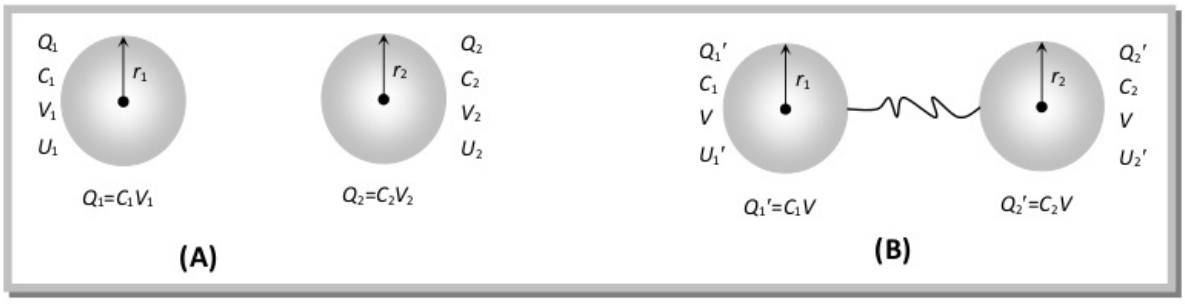
Energy Density Between the Plates of a Parallel Plate Capacitor.

The energy stored in a capacitor is not localised on the charges or the plates but is distributed in the field. And as in case of a paral el plate capacitor field is only between the plates i.e. in a volume (A× d), the so cal ed **energy density.**

$$\text{Hence Energy density} = \frac{\text{Energy}}{\text{Volume}} = \frac{\frac{1}{2}CV^2}{Ad} = \frac{1}{2}\left[\frac{\varepsilon_0 A}{d}\right]\frac{V^2}{Ad} = \frac{1}{2}\varepsilon_0\left(\frac{V}{d}\right)^2 = \frac{1}{2}\varepsilon_0 E^2.$$

Sharing of charge : When two conductors one connected using a conducting wire, charge begins to flow from one conductor to another till both have the same potential due to flow of charge there exist loss of energy in the form of heat.

Suppose there are two spherical conductors of radii 1randr2, having charge Q_1 and Q_2,potential V_1 and V_2,energies U1 and U2 and capacitance C_1 and C_2 respectively, as shown in figure. If these two spheres are connected through a conducting wire, then variation of charge, potential and energy takes place.



(i) **New charge** : According to the conservation of charge Q1. Q2 □ Q'1. Q'2 □ Q (say), also

$$\frac{Q_1'}{Q_2'} = \frac{C_1V}{C_2V} = \frac{4\pi\varepsilon_0 r_1}{4\pi\varepsilon_0 r_2}, \frac{Q_1'}{Q_2'} = \frac{r_1}{r_2} \quad \Rightarrow \quad 1 + \frac{Q_1'}{Q_2'} = 1 + \frac{r_1}{r_2} \Rightarrow \quad \frac{Q_1' + Q_2'}{Q_2'} = \frac{r_1 + r_2}{r_2}$$

$$\Rightarrow \quad Q_2' = Q\left[\frac{r_2}{r_1 + r_2}\right] \quad \text{and similarly} \quad Q_1' = Q\left[\frac{r_1}{r_1 + r_2}\right]$$

(ii) **Common potential** : Common potential $(V) = \frac{\text{Total charge}}{\text{Total capacity}} = \frac{Q_1 + Q_2}{C_1 + C_2} = \frac{Q_1' + Q_2'}{C_1 + C_2} \Rightarrow$

$$V = \frac{C_1V_1 + C_2V_2}{C_1 + C_2}$$

(iii) **Energy loss** : As electrical energy stored in the system before and after connecting the spheres is

$$U_i = \frac{1}{2}C_1V_1^2 + \frac{1}{2}C_2V_2^2$$

$$\text{and } U_f = \frac{1}{2}(C_1 + C_2).V^2 = \frac{1}{2}(C_1 + C_2)\left(\frac{C_1V_1 + C_2V_2}{C_1 + C_2}\right)^2$$

$$\text{so energy loss } \Delta U = U_i - U_f = \frac{C_1C_2}{2(C_1 + C_2)}(V_1 - V_2)^2$$

Problem 1 Two spheres A and B of radius 4 cm and 6 cm are given charges of 80μC and 40μC respectively. If they are connected by a fine wire, the amount of charge flowing from one to the other is

(a) 20μ C from A to B (b) 16μ C from A to B

(c) 32μ C from B to A (d) 32μ C from A to B

Solution: (d) Total charge Q = 80 + 40 + 120μ C. By using the formula $Q_1' = Q\left[\frac{r_1}{r_1 + r_2}\right]$ charge on sphere A is $Q_A' = Q\left[\frac{r_A}{r_A + r_B}\right] = 120\left[\frac{4}{4+6}\right] = 48\ \mu C$. Initial y it was 80 μ,C i.e., 32μ C charge flows from A to B.

Problem 2- Two hollow spheres are charged positively. The smal er one is at 50 V and the bigger one is at 100 V. How should they be arranged so that the charge flows from the smaller to the bigger sphere when they are connected by a wire

(a) By placing them close to each other

(b) By placing them at very large distance from each other

(c) By placing the smal er sphere inside the bigger one

(d) Information is insufficient

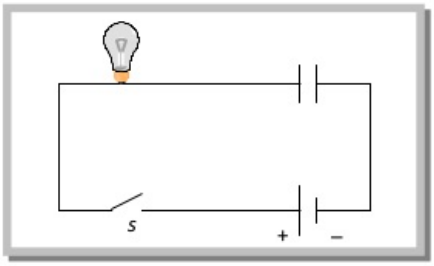
Solution: (c) By placing the smal er sphere inside the bigger one. The potential of the smaller one will now be 150 V. So on connecting it with the bigger one charge will flow from the smaller one to the bigger one.

We know that charge given to a conductor increases it's potential i.e., $Q \propto V \Rightarrow Q = CV$

Where C is a proportionality constant, cal ed capacity or capacitance of conductor.

Hence capacitance is the ability of conductor to hold the charge.

Problem : 3 A light bulb, a capacitor and a bat ery are connected together as shown here, with switch S initial y open. When the switch S is closed, which one of the following is true



(a) The bulb will light up for an instant when the capacitor starts charging

(b) The bulb will light up when the capacitor is ful y charged

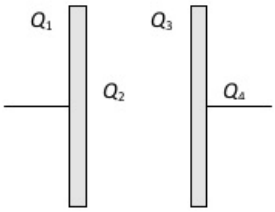
(c) The bulb will not light up at al

(d) The bulb will light up and go off at regular intervals

Solution: (a) Current through the circuit can flow only for the smal time of charging, once capacitor get's charged it blocks the current through the circuit and bulb will go off.

Problem-4

In an isolated parallel plate capacitor of capacitance C, the four surface have charges Q_1 , Q_2 , Q_3 and Q_4 as shown.



The potential difference between the plates is

$$\text{(a)}\ \frac{Q_1+Q_2+Q_3+Q_4}{2C} \quad \text{(b)}\ \frac{Q_2+Q_3}{2C} \quad \text{(c)}\ \frac{Q_2-Q_3}{2C} \quad \text{(d)}\ \frac{Q_1+Q_4}{2C}$$

Solution: (c) Plane conducting surfaces facing each other must have equal and opposite charge densities. Here as the plate areas are equal, Q2 =-Q3 .

The charge on a capacitor means the charge on the inner surface of the positive plate (here it is Q2)

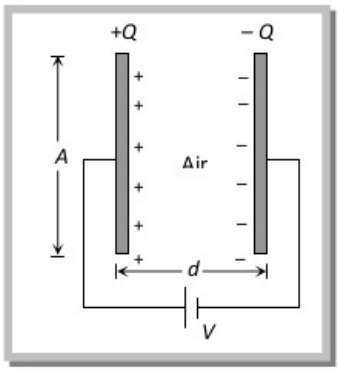
Potential difference between the plates $= \frac{\text{charge}}{\text{capacitance}} = \frac{Q_2}{C} = \frac{2Q_2}{2C}$

$$= \frac{Q_2-(-Q_2)}{2C} = \frac{Q_2-Q_3}{2C}.$$

Variation of Different Variables (*Q, C, V, E and U*) of Paral el Plate Capacitor.

Suppose we have an air fil ed charged paral el plate capacitor having variables are as follows :

Charge $-Q$, Surface charge density $-\sigma = \frac{Q}{A}$, Capacitance $-C = \frac{\varepsilon_0 A}{d}$



Potential difference across the plates $-V = E.d$

Electric field between the plates $-E = \frac{\sigma}{\varepsilon_0} = \frac{Q}{A\varepsilon_0}$

Energy stored $-U = \frac{1}{2}CV^2 = \frac{Q^2}{2C} = \frac{1}{2}QV$

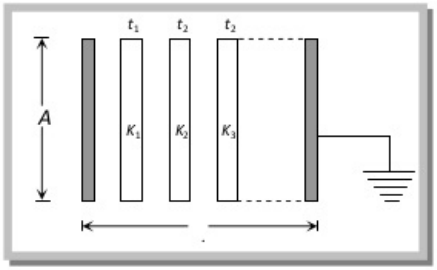
When dielectric is partial y filled between the plates : If a dielectric slab of thickness t(t < d) is inserted between the plates as shown below, then E = Main electric field between the plates, E_i =Induced electric field in dielectric. E'= (E - E_i) = The reduced value of electric field in the dielectric. Potential difference between the two plates of capacitor is given by

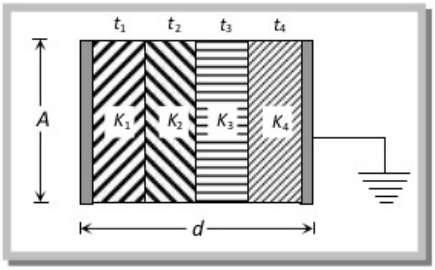
$$V' = E(d-t) + E't = E(d-t) + \frac{E}{K}.t$$

$$\Rightarrow V' = E\left(d - t + \frac{t}{K}\right) = \frac{\sigma}{\varepsilon_0}\left(d - t + \frac{t}{K}\right) = \frac{Q}{A\varepsilon_0}\left(d - t + \frac{t}{K}\right)$$

Now capacitance of the capacitor

$$C' = \frac{Q}{V'} \qquad \Rightarrow \qquad C' = \frac{\varepsilon_0 A}{d - t + \frac{t}{K}}$$





$$C' = \frac{\varepsilon_0 A}{d - (t_1 + t_2 + t_3 + ...) + \left(\frac{t_1}{K_1} + \frac{t_2}{K_2} + \frac{t_3}{K_3} + ...\right)}$$

$$C' = \frac{\varepsilon_0 A}{\left(\frac{t_1}{K_1} + \frac{t_2}{K_2} + \frac{t_3}{K_3} + \frac{t_4}{K_4}\right)}$$

Force Between the Plates of a Parallel Plate Capacitor.

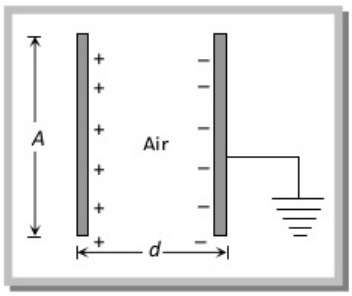
Field due to charge on one plate on the other is ° , hence the force F = QE

$$E = \frac{\sigma}{2\varepsilon_0}$$

$$F = -\sigma A \times \left(\frac{\sigma}{2\varepsilon_0}\right) = -\frac{\sigma^2}{2\varepsilon_0} A$$

$$\Rightarrow \qquad |F| = \frac{\sigma^2 A}{2\varepsilon_0} = \frac{Q^2}{2\varepsilon_0 A}$$

∠ε_0



Problem :5 A capacitor when fil ed with a dielectric K□ 3 has charge Q0 , voltage 0 V and field E0 . If the dielectric is replaced with another one having K = 9, the new values of charge, voltage and field will be respectively

(a) $3Q_0, 3V_0, 3E_0$ (b) $Q_0, 3V_0, 3E_0$ (c) $Q_0, \frac{V_0}{3}, 3E_0$ (d) $Q_0, \frac{V_0}{3}, \frac{E_0}{3}$

Solution: (d) Suppose, charge, potential difference and electric field for capacitor without dielectric medium are Q, V and E respectively

With dielectric medium of K = 3 With dielectric medium of K = 9

Charge $Q_0 = Q$ Charge $Q' = Q = Q_0$

Potential difference $V_0 = \frac{V}{3}$ Potential difference $V' = \frac{V}{9} = \frac{V_0}{3}$

Electric field $E_0 = \frac{E}{3}$ Electric field $E' = \frac{E}{9} = \frac{E_0}{3}$.

Problem 6 - An air capacitor of capacity C □ 10μF is connected to a constant voltage bat ery of 12 V. Now the space between the plates is filled with a liquid of dielectric constant 5. The charge that flows now from battery to the capacitor is

(a) 120μC (b) 600μC (c) 480μC (d) 24μC

Solution: (c) Initially charge on the capacitor Q_i = 10 x 12 μ 120μC

When dielectric medium is filled, so capacitance becomes K times, i.e. new capacitance C'= 5 x ⎓10= 5μ C
Final charge on the capacitor Q_f = 50 ⎓12 = 600μ C

Hence additional charge supplied by the battery = $Q_f = Q_i$ = 480μC .

Grouping of Capacitors.

Series grouping	Parallel grouping

(1) Charge on each capacitor remains same and equals to the main charge supplied by the battery

$V = V_1 + V_2 + V_3$

(2) Equivalent capacitance

$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} \text{ or}$$

$$C_{eq} = (C_1^{-1} + C_2^{-1} + C_3^{-1})^{-1}$$

(3) In series combination potential difference and energy distribution in the reverse ratio of capacitance i.e., $V \propto \frac{1}{C}$ and $U \propto \frac{1}{C}$.

(4) If two capacitors having capacitances C1 and C2 are connected in series then $\boldsymbol{C_{eq} = \frac{C_1 C_2}{C_1 + C_2}} = \frac{\text{Multiplication}}{\text{Addition}}$

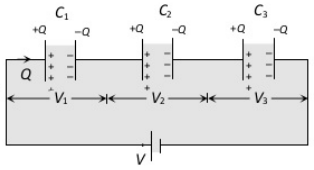
$V_1 = \left(\frac{C_1}{C_1 + C_2}\right).V$ and $V_2 = \left(\frac{C_2}{C_1 + C_2}\right).V$

(5) If n identical capacitors each having capacitances C are connected in series with supply voltage V then Equivalent capacitance $C_{eq} = nC$ and and Potential difference across each capacitor $V' = \frac{V}{n}$.

(1) Potential difference across each capacitor remains same and equal to the applied potential difference

$Q = Q_1 + Q_2 + Q_3$

(2) $C_{eq} = C_1 + C_2 + C_3$



(3) In parallel combination charge and energy distributes in the ratio of capacitance i.e. $Q \propto$ C and $U \propto C$

(4) If two capacitors having capacitance C_1 and C_2 respectively are connected in parallel then

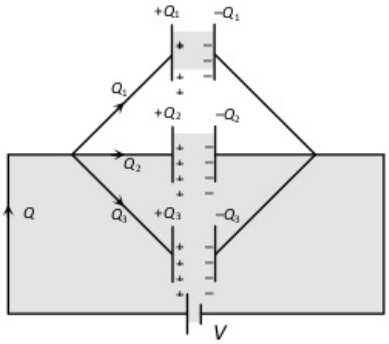
$\boldsymbol{C_{eq} = C_1 + C_2}$

$Q_1 = \left(\frac{C_1}{C_1 + C_2}\right).Q$ and $Q_2 = \left(\frac{C_2}{C_1 + C_2}\right).Q$

(5) If n identical capacitors are connected in parallel

Equivalent capacitance $C_{eq} = \frac{C}{n}$

and Charge on each capacitor $Q' = \frac{Q}{n}$



ADDITIONAL INFORMATION:

1. When a battery is disconnected after charging a capacitor and on inserting slab or combining other capacitors (uncharged) would not change the total charge of the system.

2. Capacitor connected to a bat ery such that the capacitor is charged completely and battery is still connected, inserting slab or combining other capacitors would not change the potential difference across the capacitors.

TOTAL ENERGY STORED IN COMBINATION CAPACITORS

Total Energy stored in the combination of capacitors is the sum of energies stored in each of the capacitor independent of the mode of combination.

Series combination:

Q is constant

U= Q^2/2C Where C is he equivalent capacitance.

U=Q^2/2(1/C_1+1/C_2 - - - - - - -)

U= U1+U2+U3- - - - - - - - -

Parallel combination:

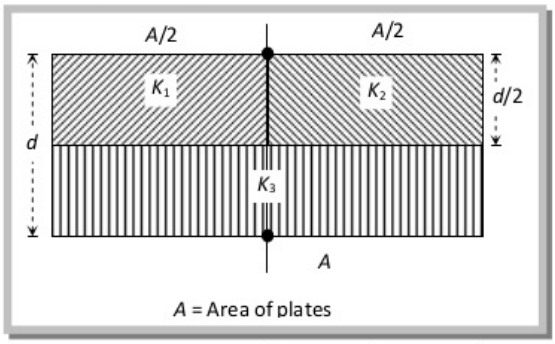
V is constant

U=CV^2/2 where C is the equivalent capacitance.

U=V2/2(C1+C1+C3- - - - -)

U= U1+U2+U3- - - - - - - - -

Problem : 7 A paral el plate capacitor of area A, plate separation d and capacitance C is filled with three different dielectric materials having dielectric constants K1, K2 and K3 as shown in fig. If a single dielectric material is to be used to have the same capacitance C in this capacitor, then its dielectric constant K is given by



(a) $\frac{1}{K}=\frac{1}{K_1}+\frac{1}{K_2}+\frac{1}{2K_3}$ (b) $\frac{1}{K}=\frac{1}{K_1+K_2}+\frac{1}{2K_3}$

(c) $K=\frac{K_1K_2}{K_1+K_2}+2K_3$ (d) $K=K_1+K_2+2K_3$

Solution: (b) The effective capacitance is given by $\frac{1}{C_{eq}}=\frac{d}{\varepsilon_0 A}\left[\frac{1}{2K_3}+\frac{1}{(K_1+K_2)}\right]$

The capacitance of capacitor with single dielectric of dielectric constant K is $C=\frac{K\varepsilon_0 A}{d}$

According to question $C_{eq}=C$ $i.e.,$ $\frac{\varepsilon_0 A}{d\left[\frac{1}{\quad}+\frac{1}{\quad}\right]}=\frac{K\varepsilon_0 A}{d}$

$$\lfloor 2K_3 \quad K_1 + K_2 \rfloor$$

$$\Rightarrow \frac{1}{K} = \frac{1}{2K_3} + \frac{1}{K_1 + K_2}.$$

Problem: 8 Given a number of capacitors label ed as 8μF, 250 V. Find the minimum number of capacitors needed to get an arrangement equivalent to 16μF, 1000V

(a) 4 (b) 16 (c) 32 (d)64

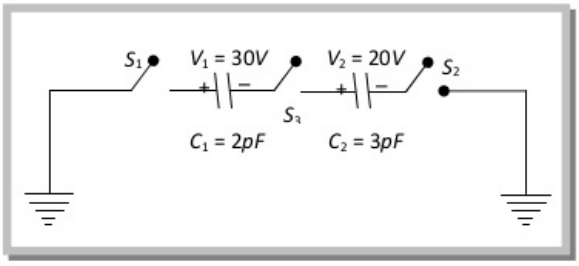
Solution: (c) Let C = 8 μF, C⊣ = 16 μF and V = 250 volt, V⊣ = 1000 V

Suppose m rows of given capacitors are connected in parallel which each row contains n capacitor then

Potential difference across each capacitors $V = \frac{V'}{n}$ and equivalent capacitance of network $C = \frac{mC}{n}.$

On putting the values, we get n = 4 and m = 8. Hence total capacitors = m × n = 8 × 4 = 32.

Problem: 9 For the circuit shown, which of the following statements is true



(a) With S1 closed, V1 = 15 V, V2 = 20 V

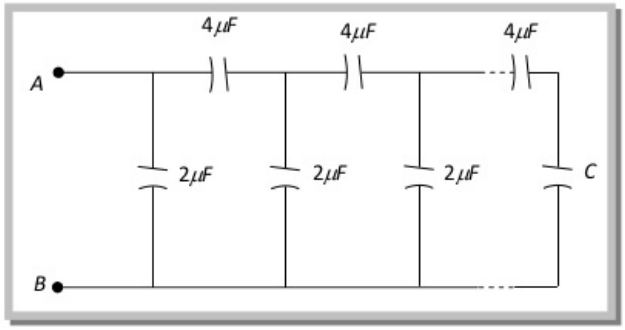
(b) With S3 closed, V1 = V2 = 25 V

(c) With S1 and S2 closed V1 = V2 = 0

(d) With S1 and S3 closed V1 = 30 V, V2 = 20 V

Solution: (d) When S3 is closed, due to at raction with opposite charge, no flow of charge takes place through S3. Therefore, potential difference across capacitor plates remains unchanged or V1 = 30 V and V2 = 20 V.

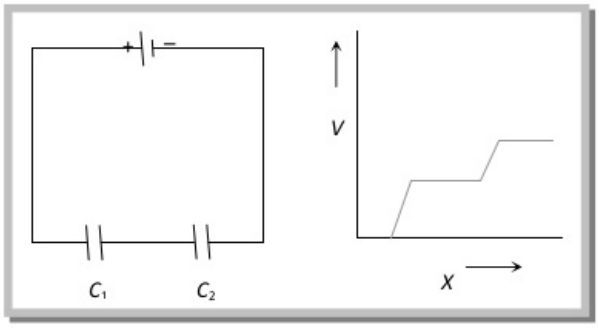
Problem: 10 A finite ladder is constructed by connecting several sections of 2μ F 4,μ F capacitor combinations as shown in the figure. It is terminated by a capacitor of capacitance C. What value should be chosen for C, such that the equivalent capacitance of the ladder between the points A and B becomes independent of the number of sections in between



(a) 4μF (b) 2μF

Solution: (a)

problem: 11 Figure shows two capacitors connected in series and joined to a battery. The graph shows the variation in potential as one moves from left to right on the branch containing the capacitors.



(a) $C_1 > C_2$

(b) $C_1 = C_2$

(c) $C_1 < C_2$

(d) The information is insufficient to decide the relation between C_1 and C_2

Solution: (c) According to graph we can say that potential difference across the capacitor C_1 is more than that across C_2 . Since charge Q is same i.e., $Q = C_1V_1 = C_2V_2 \Rightarrow \frac{C_1}{C_2} = \frac{V_2}{V_1} \quad \Rightarrow \quad C_1 < C_2 \qquad (V_1 > V_2).$

Problem-12

A capacitor of capacitance C_1 = 1μF can withstand maximum voltage V_1 = 6 KV (kilo-volt) and another capacitor of capacitance C_2 = 3μF can withstand maximum voltage V_2 = 4KV. When the two capacitors are connected in series, the combined system can withstand a maximum voltage of

(a) 4 KV (b) 6 KV (c) 8 KV (d) 10 KV

Solution: (c) We know Q = CV

Hence $(Q_1)_{max}$ = 6 mC while $(Q_2)_{max}$ = 12 mC

However in series charge is same so maximum charge on C_2 will also be 6 mC (and not 12 mC) and hence

potential difference across C_2 will be $V_2 = \frac{6mC}{3\mu F} = 2KV$ and as in series V = V1 + V2

So V_{max} = 6KV + 2KV = 8KV

Problem 13 .A parallel plate capacitor of capacitance C**0** and plate separation d is charged to a potential V. The battery is disconnected and then a dielectric slab of thickness t (t < d) is introduced between its plates. What should be the change in plate separation to bring the potential to V.(Dielectric constant of the slab is K)

Solution- Separation between the plates x = t - t / k

Capacitors are rated in Farads, and the standard symbol is 'C' or 'F', depending upon the context. A Farad is so big that capacitors are most commonly rated in micro-Farads (μF).

Activity 1: Charging a capacitor at constant current

Background to the experiment

When a capacitor is charged by connecting it to a bat ery or other dc power supply, the current in the circuit gradual y fal s to zero. The rate at which this happens depends on both the capacitance of the capacitor and the presence of any resistance in the circuit. If the resistance of the circuit is high, the current will be correspondingly smal and the capacitor will charge up more slowly than if there were less resistance in the circuit.

Using a variable resistor, with a bit of manual dexterity, you can keep the current constant and time how long it takes to charge a capacitor. By knowing both the time and the current, you can determine the charge stored on the capacitor.

Then, by charging the capacitor to different voltages, you can establish experimentally the

relationship between the amount of charge and the pd across the capacitor resulting from it.

You will need

power supply, 5 V dc

digital multimeter, used as ammeter

digital multimeter, used as voltmeter

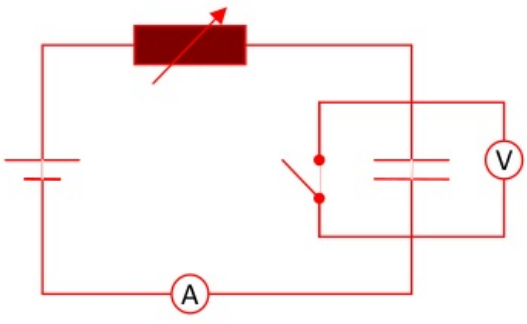
capacitor, 470 μF

potentiometer, mounted with 4 mm sockets, 100 kΩ

leads, 4 mm plus shorting switch

hand-held stop watch

Constant current charging



Watch the supply pump a fixed number of coulombs onto each capacitor plate each second.How is the charge on one plate changing with time? So how is the pd changing with time?

Can you think of a way to show this?

Examining the results

From the current and time measurements, you can use Q = It to determine the amount of charge which flowed onto the capacitor plates. If you do this for cunningly chosen measurements, you are now in a position to examine the relationship between the charge andthe pd across the capacitor which results from the redistribution of charge on its surfaces. A quick look at the results will show that more charge is needed to raise the pd to a greater value.

Outcomes

1. You will understand bet er the process by which a capacitor is charged.

2. By focusing on the simplicity of charging at a constant current, you can see how the redistribution of charge results in a potential difference across the capacitor.

3. You will be able to see that this leads to the relationship ‘pd across a capacitor is proportional to the charge stored on one plate of the capacitor’.

Practical advice

Before showing students this demonstration, they should be aware of current as a flow of charge in a circuit and have tackled some of the problems involving the calculation of charge and the use of Q = I t. They might be shown initial y what happens when the capacitor is charged without changing the resistance, i.e. that the current gradual y falls, and this should simply be introduced as a nuisance at this stage. They need to be clear that the variable resistance is there simply to al ow you to keep the current constant.

Close the switch and use the variable resistor to set the ammeter to some convenient value, e.g. 100 mA. When you are ready, remove the shorting link across the capacitor, start timing and adjust the control on the variable resistor to maintain the current at the value you have set. You will probably have to practise this a few times – it can be quite tricky. Carry on adjusting the resistor for as long as you can. Connect the digital voltmeter briefly across the capacitor to measure the pd that has been generated by the redistribution of charge.

Record the charging current and the time as wel as the pd across the capacitor. You will probably wish to repeat this measurement at least once or twice to al ow for the difficulty you have in keeping the current constant.

You might repeat this process using different pds, if you want to take it further, or to use a computer-based oscil oscope to get plots of charging current / time and pd across capacitor / time.

You will probably not have time to do the demo in great detail, but it is wel worth the effort to practise a bit at keeping the current steady – surprisingly difficult if you have not done it before.

Explain the function of the short circuit link across the capacitor, which al ows you to set the initial charging current to a convenient value. You will have already taught that the capacitor is an unusual device, which does not permit a flow of current through it. You wil also have to explain away that you eventual y run out of control when you have reduced the resistance to zero and the current will then fal . A simple and effective, but not total y accurate procedure is to keep on timing until the current has fal en to half the initial value. For an appropriate group of able students, this could be an additional teaching point.

If you have done the experiment reasonably carefully, and have results for different pds, students can plot a graph of Q against pd

If you have time, it is a good idea to let students have a try as well.

Alternative approaches

The approach will depend on students’ prior knowledge. If they already know Q = CV, then the activity becomes one in showing that the different gradients of the graph relate to different values of the capacitance. You may wish to direct learners to use it from this standpoint, particularly if there is time for students to do the experiment themselves.

Activity 2

Capacitance and the equation C =Q/V

Having established that there is charge on each capacitor plate, the next stage is to establish the relationship between charge and potential difference across the capacitor.

Demonstration:

Charging a capacitor

The experimental demonstration 'charging a capacitor at a constant rate' shows that the potential difference across the capacitor is proportional to the charge.

Problem 1 : **Charging a capacitor at constant current**

Discussion:

Defining capacitance and the farad

The experiment shows that Q ∝ V, or Q = constant × V. This constant is called the capacitance, C, of the capacitor and this is measured in farads (F). So capacitance is charge stored per volt, and farads = coulombs/volts.

It is a good idea to point out that 1 farad is a very large capacitance and that most capacitors will be micro, μ, - (10^{-6}), nano- (10^{-9}), or pico- (10^{-12}) farads. The capacitance of the planet Earth, considered as an isolated sphere of radius R, using C = 4 πεo R = 711 μF.

Learner's experiment:

Charge proportional to voltage – first alternative

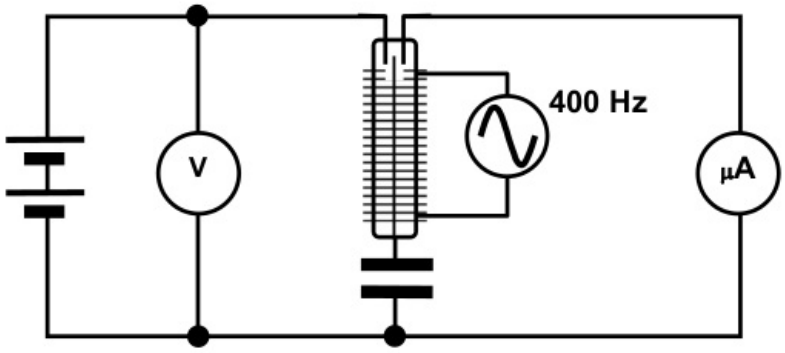
The relationship between charge and potential difference can be investigated further by the students themselves. Two experiments are possible; this one makes use of a coulomb meter.

By charging a suitable capacitor to different voltages and measuring the charge stored each time, you have a rapid confirmation of the relationship Q ∝ V. The experiment can be repeated with different capacitors. Plot a graph of Q against V.

Problem 2 : Measuring the charge on a capacitor

Charge proportional to voltage – second alternative

The second investigation of the relationship between charge and pd makes use of a change-over reed switch. Students may have met simple on/off reed switches in technology or even in primary school.



(resourcefulphysics.org)

Although this is a more difficult experiment to perform, it has value because it can be extended to investigate the factors determining capacitance of a paral el plate capacitor if this is needed for your specification.

From either experiment, a graph of Q against V can be plotted. This is helpful later when discussing the energy stored in a capacitor. (N.B. The graph from a reed switch experiment will not pass through the origin so the effect of stray

capacitance in the experiment will have to be explained)

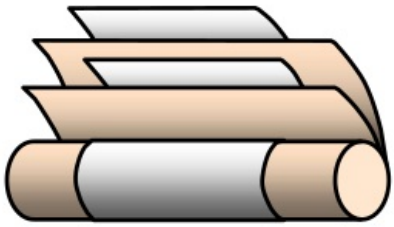
Using a reed switch to measure capacitance

Discussion:

Factors affecting C

If your specification requires the study of the equation $C = \varepsilon_O \varepsilon_r A/d$ then this is a convenient point to cover that work.

It is a good time to introduce the idea that many ‘tubular’ shaped capacitors are, in fact, a parallel plate capacitor which has been rolled up and fil ed with a dielectric. Why? (A large area with a smal gap gives reasonable values of capacitance; dielectric increases capacitance; rolling reduces the overal size.)



Student experiment:

Factors affecting C

Using a reed switch, or a digital capacitance meter, investigate the factors determining capacitance for a paral el plate capacitor.

If you do not have a reed switch many cheap digital multimeters now have a capacitance meter that covers the pF and nF range, which will work effectively here.

By using paral el plates as the capacitor in this experiment, the relationship between capacitance and area can be found by altering the area of overlap while using spacers leads to the relationship between capacitance and separation. Placing plastic sheets between the plates shows the effect of a dielectric and shows why the relative permit ivity appears in the formula. If time is short, these three experiments could be done as group activities, with groups reporting back on their findings.

Discussion:

Permittivity

Discuss the outcomes of the experiments and the significance of □o, the permittivity of free space. Deduce its units of F m-1 or $C^2\ N^{-1}\ m^{-2}$.

Discussion:

Working with real capacitors

Take a selection of capacitors and look at the information written on each. This will include the capacitance and the maximum working voltage. On an electrolytic capacitor there will also be an indication of the polarity for each terminal (and there may be a maximum ripple current).

Discuss what the markings mean and compare the charge stored by each capacitor at maximum voltage (practice in using Q = C V

How does this relate to the physical size of the capacitor? (This is unlikely to be simply that the larger the capacitance the bigger the capacitor. The working voltage is important, as is the material between the plates.)

CONCLUSIVE REMARKS-

After knowing the basic concept of capacitor e.g principle, charging, energy, discharging,

grouping etc. learner will be able to apply the use of same in daily life.

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SONOMETER (EXPERIMENT)

Introduction-

A **monochord,** also known as sonometer, is an ancient musical and scientific laboratory instrument, original y involving one (mono) string (chord).

In a monochord, one strings, fixed at both ends, are stretched over a sound box while one or more movable bridges are manipulated to demonstrate mathematical relationships between sound frequencies. "With its single string, movable bridge and graduated rule, the monochord straddled the gap between notes and numbers, intervals and ratios, sense-perception and mathematical reason."

Sonometer is device used to measure the frequency of tunning fork. A wire is stretched byappling tension at one end and fixing the other end to a screw that is provided. If ithe string is subjected to a disturbance it would vibrate with a certain frequency.

LEARNING OUTCOMES-

After doing this experiment learner will be able to

1. Study dependence of speed of sound on thickness of string , length of string and mass per unit length of string.

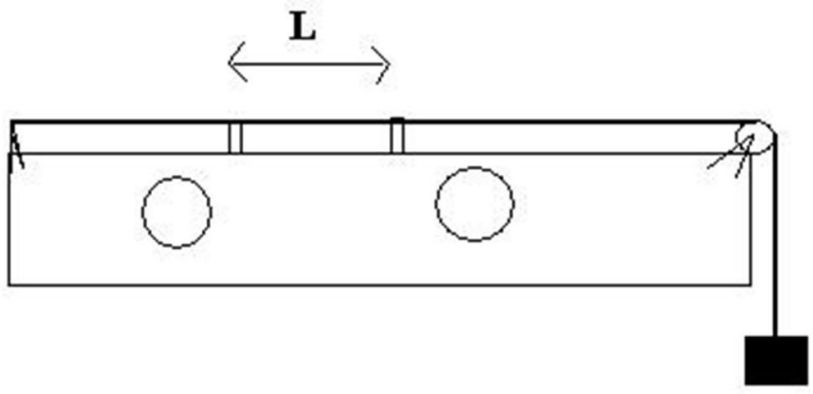
2. Study dependence of frequency of vibration on tension in string , length of string and mass per unit length of string.

3. Understand frequency produced by tuning fork.

4. To differentiate between different intensity of sound.

APPARATUS AND USE -

For sonometer experiment, the apparatus consist of a wooden box which is hal ow and has holes on the sides for free vibrations of air inside. A thin wire of whose linear density is known is stretched over the bridges by means of hanging weights over a pul ey with other end fixed. By changing the distance between the wooden bridges the length of the vibrating column can be changed. A smal paper rider is placed on the string between the bridges. A standard tuning fork is struck with a rubber hammer and the stem of the fork is kept on the box. Now by moving the distance of the bridges, the length of the vibrating column can be adjusted until the frequency of vibrations of the string is equal to the frequency of tuning fork. At resonance (frequencies equal) the paper rider is thrown off the wire.



CONCEPTUAL UNDERSTANDING

Experiment 1

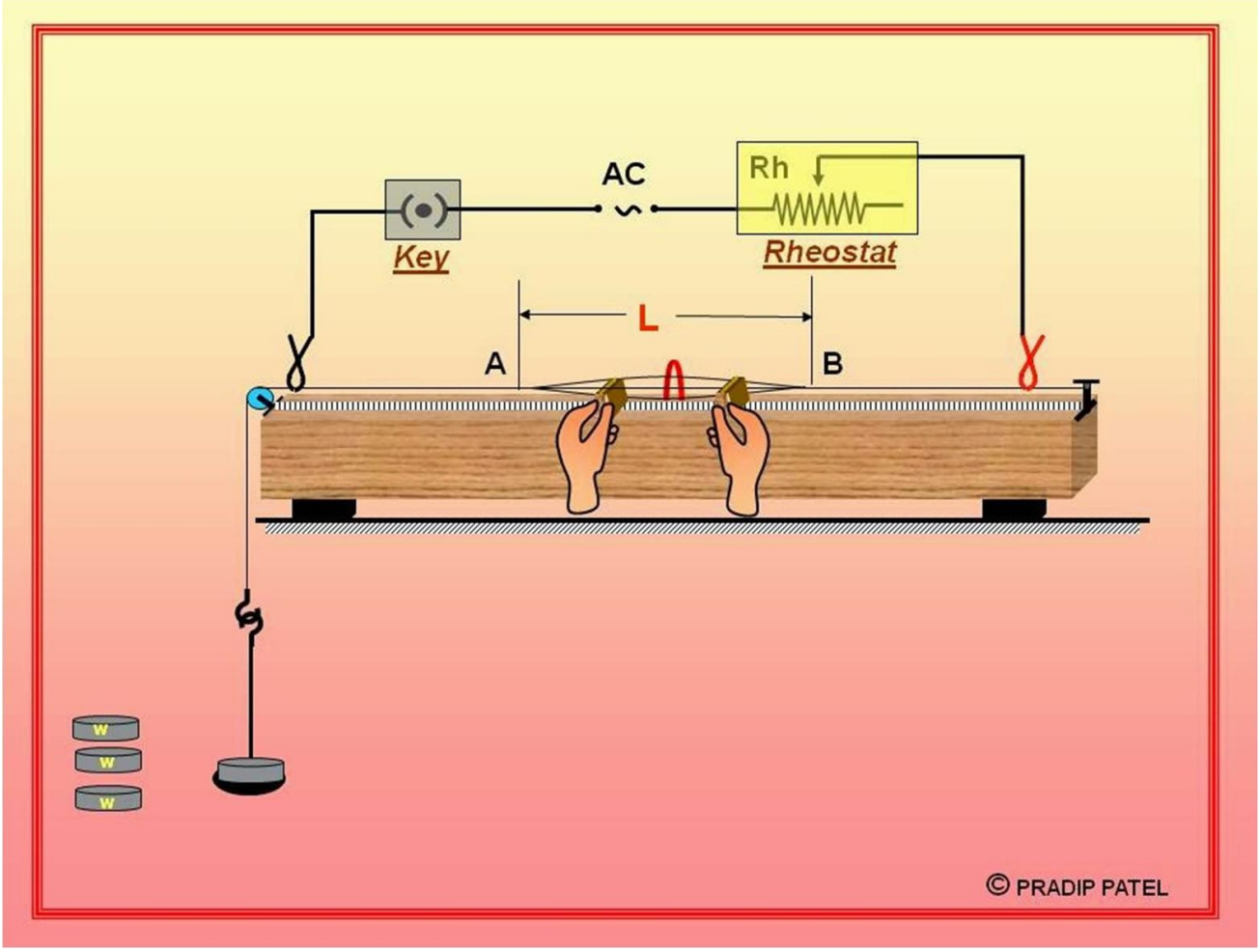
Our Objective:

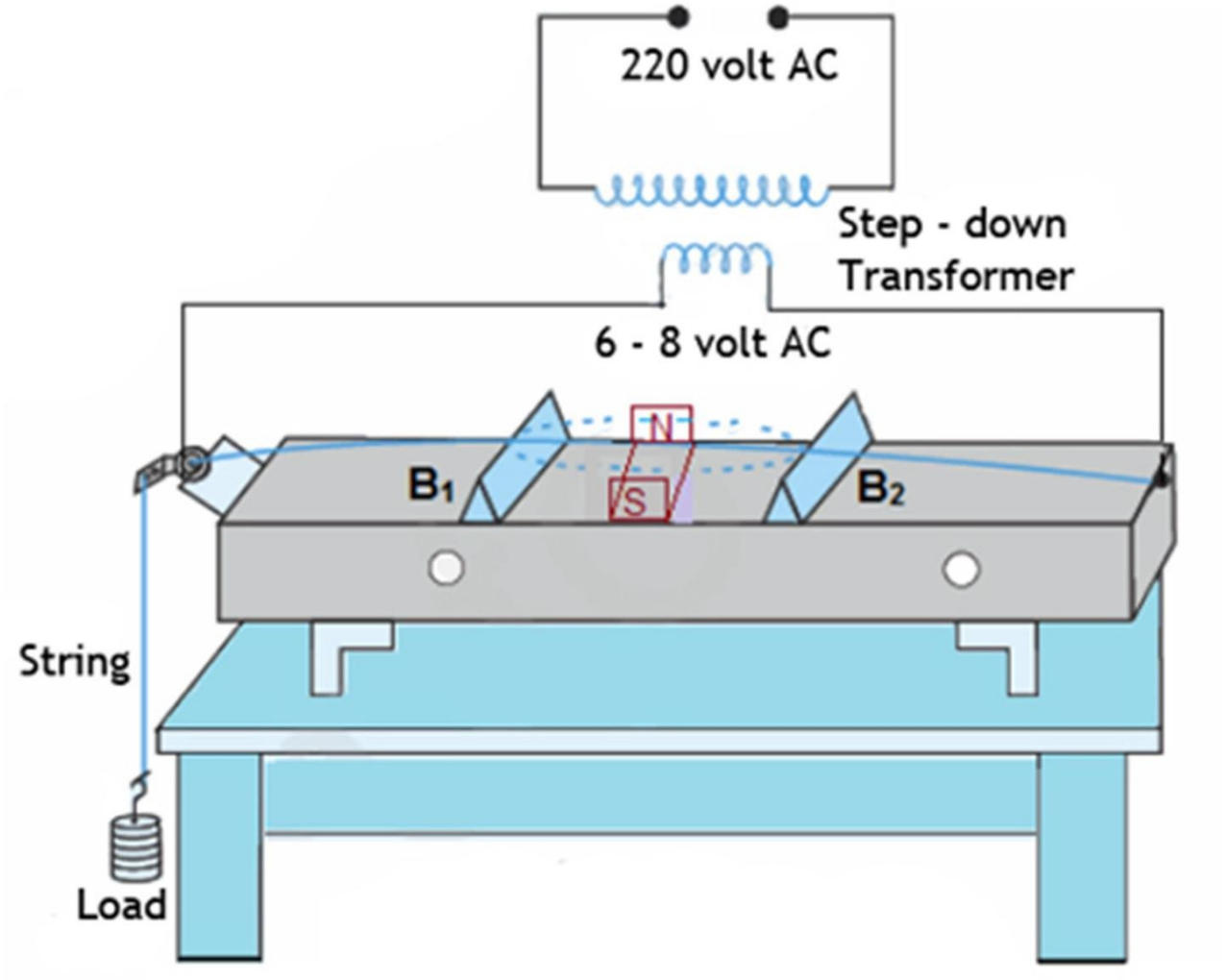
To determine the frequency of alternating current using a sonometer.

The Theory:

A sonometer is used to determine the frequency of alternating current. A step down transformer is used for the determination of frequency of A.C. because the voltage of the A.C. mains is 220V, which is dangerous. The step down transformer reduces this voltage to 6 volts.

The string wire of the sonometer is a non-magnetic metal ic wire like brass or copper. A horse shoe magnet is placed at the middle of the sonometer wire so that the magnetic field is applied perpendicular to the sonometer wire in a horizontal plane. When an alternating current of definite frequency passes through the wire there will be interaction between the magnetic field and the current carrying conductor. So a force will act on the conductor in a direction perpendicular to both the field and the direction of current. When A.C. is passing through the conductor, since the current direction reverses periodical y, the direction of force also reverse periodical y and hence, the conductor vibrates. Since the current flowing is alternating, the wire vibrates with a frequency equal to the frequency of A. C. By adjusting the length of the vibrating wire segment, this frequency can be made equal to the natural frequency of the wire segment. Then the resonance takes place and the wire vibrates with maximum amplitude. At this stage, the length of the wire segment is cal ed the resonating length and it increases with increase in the mass of the suspended weights.





When the length 'l' of the sonometer wire vibrates with maximum amplitude, the frequency of the applied A.C. is equal to the natural frequency of the wire.

Frequency of acV=½

Where T = Mg , the tension of the wire and 'm' is the linear density of the wire.

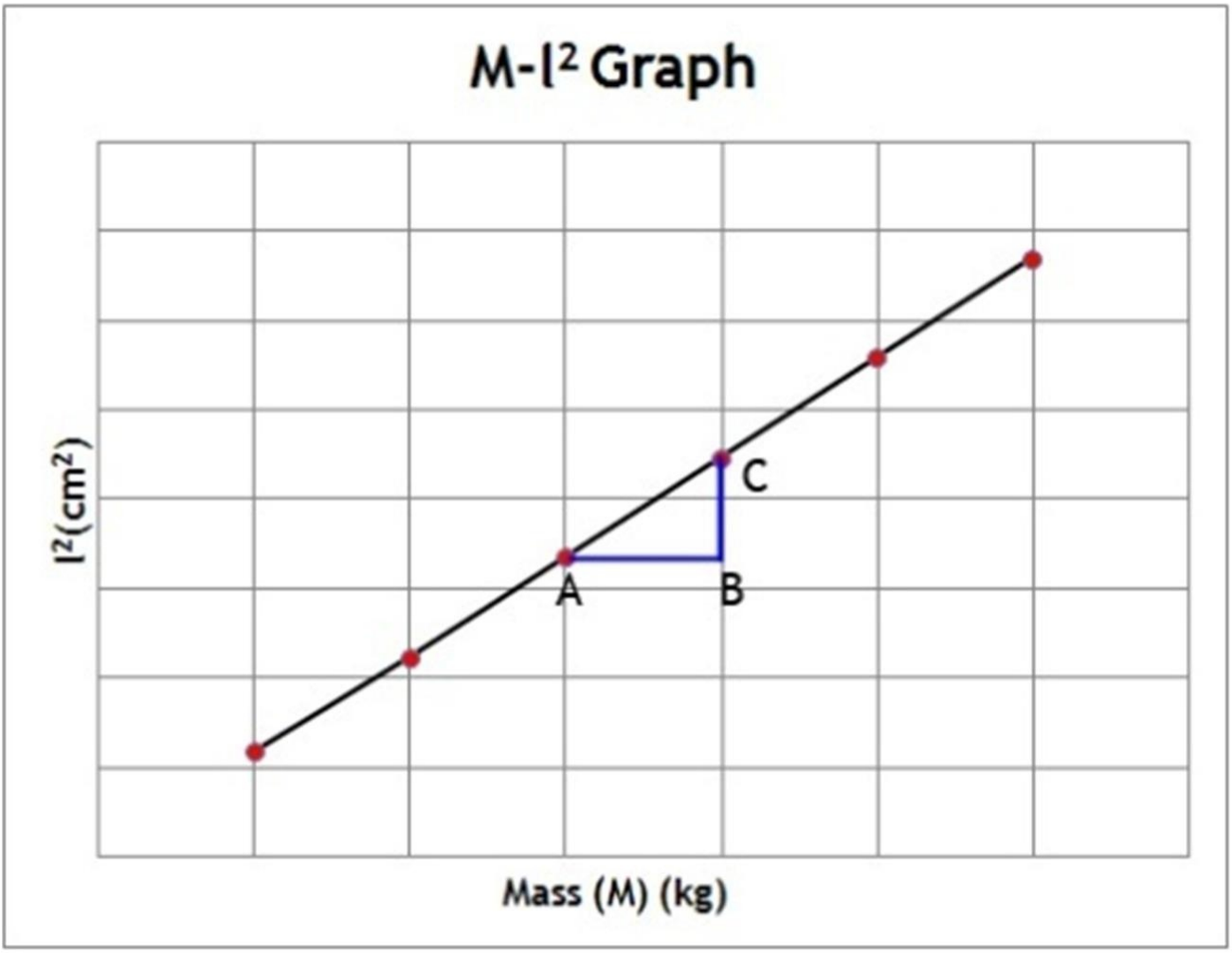
$$\therefore Frequency\,of\ ac\ \nu = \frac{1}{2l}\sqrt{\frac{T}{m}}$$

Where T = Mg, the tension of the wire and 'm' is the linear density of the wire.

$$\therefore Frequency\,of\ ac\ \nu = \frac{1}{2l}\sqrt{\frac{Mg}{m}}$$

$$= \frac{1}{2l}\sqrt{\frac{g}{m}} \times \sqrt{\frac{M}{l^2}}$$

$$\frac{M}{l^2} = cons\tan t$$



If r is the radius of the wire, and ρ is the density of its material, m = πr²ρ

The graph between mass (M) of the suspended weights and square of the resonating length (l^2) by taking M along X-axis and l^2 along Y-axis is drawn. The graph should be a straight sloping line. The slope of the line AB/BC gives the value of M/l^2, which is a constant.

$$\frac{AB}{BC} = \frac{M}{l^2} = cons\tan t$$

Learning Outcomes: Students will be able to

- ¬ʌRelate the tension of the wire, linear density of the wire and the resonating length of the wire.
- Derive the relationship between frequency of alternating current and the resonating length of the wire

Eexperiment-2

Objective

- ¬ʌTo study the relation between frequency and length of a given wire under constant tension using sonometer. To plot a graph between and l.
- ¬ʌTo study the relation between length of a given wire and tension for constant frequency using sonometer. To plot a graph between l2 and T.

What is a Sonometer ?

Learning outcomes

- ¬ʌStudents develop the idea about standing waves.
- Students understand the sonometer apparatus and its working.
- Students get the relation between frequency, length and tension of a stretched string under vibration.

Theory:

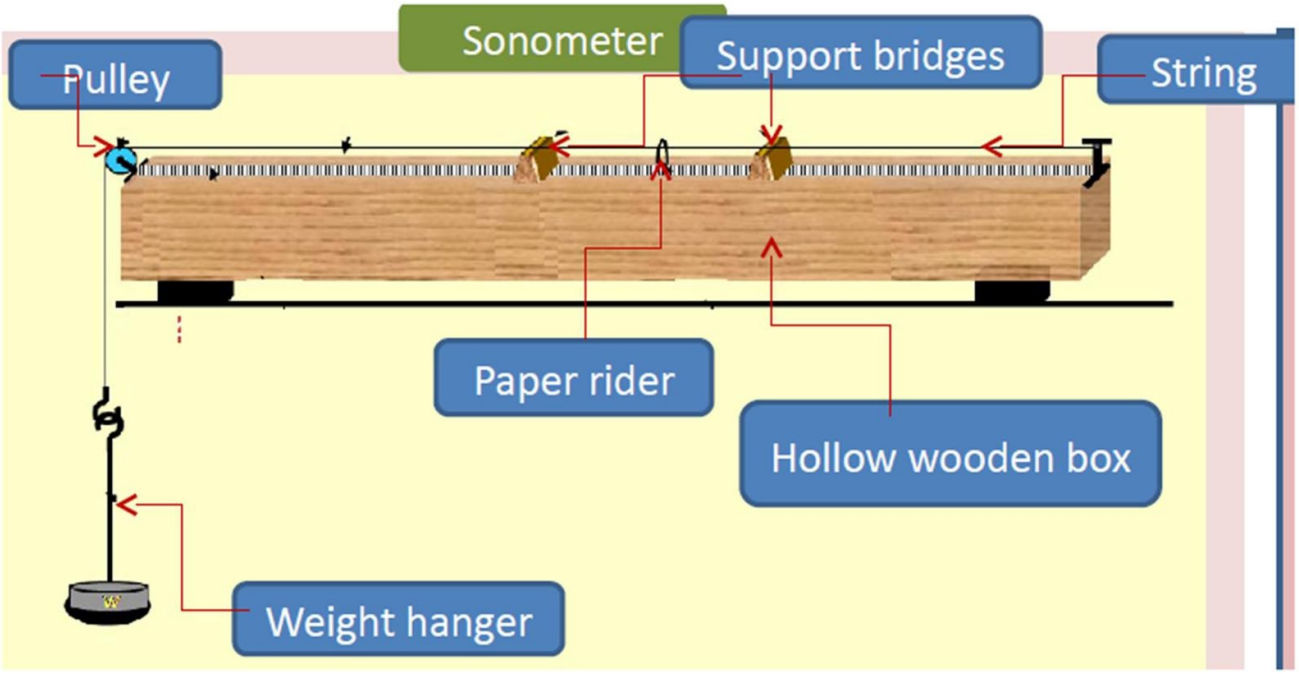
Laws of transverse vibrations on a stretched string

- ¬ʎLaw of Length: The frequency of vibration of a stretched string varies inversely as its resonating length (provided its mass per unit length and tension remain constant.)

$$v \alpha \frac{1}{l}$$

- Law of Tension: The frequency of vibration of a stretched string varies directly as the square root of its tension, (provided its resonating length and mass per unit length of the wire remains constant).

$$v \alpha \sqrt{T}$$



Relation between frequency and length

From the law of length, v***l = constant***

A graph between f and 1/l will be a straight line.

Relation between length and tension

From the equation for frequency, **√T / l = constant**

A graph between T and l^2 will be a straight line.

Activity 1

Discuss in the groups the use of sonometer in day to day life and write your observations

1. A sonometer is a diagnostic instrument used to measure the tension, frequency or density of vibrations. They are used in medical set ings to test both hearing and bone density. A sonometer, or audiometer, is used to determine hearing sensitivity, while a clinical bone sonometer measures bone density to help determine such conditions as the risk of osteoporosis.

2. In audiology, the device is used to test for hearing loss and other disorders of the ear. The audiometer measures the ability to hear sounds at frequencies normally detectable by the human ear. Several test are usual y conducted using the audiometer which will then be used to assess hearing ability. Results typical y are recorded on a chart known as an audiogram.

3. A clinical bone sonometer, approved for use in the United States by the Food and Drug Administration in 1998,

is a device which tests for the risk of bone fractures associated with osteoporosis. This test, cal ed an ultrasound bone densitometry screening, is not typical y used for diagnostic purposes; it is general y used as a risk assessment tool.Testing is often recommended for those whose personal history and lifestyle choices indicate a possible high risk for osteoporosis.

4. Testing is usual y conducted by an orthopedist, rheumatologist or neurologist specializing in the treatment of osteoporosis. The patient simply places his or her heel in the sonometer, and it is then scanned using ultrasound to determine bone density. This is a fast and low-cost procedure general y lasting 30 seconds or less.

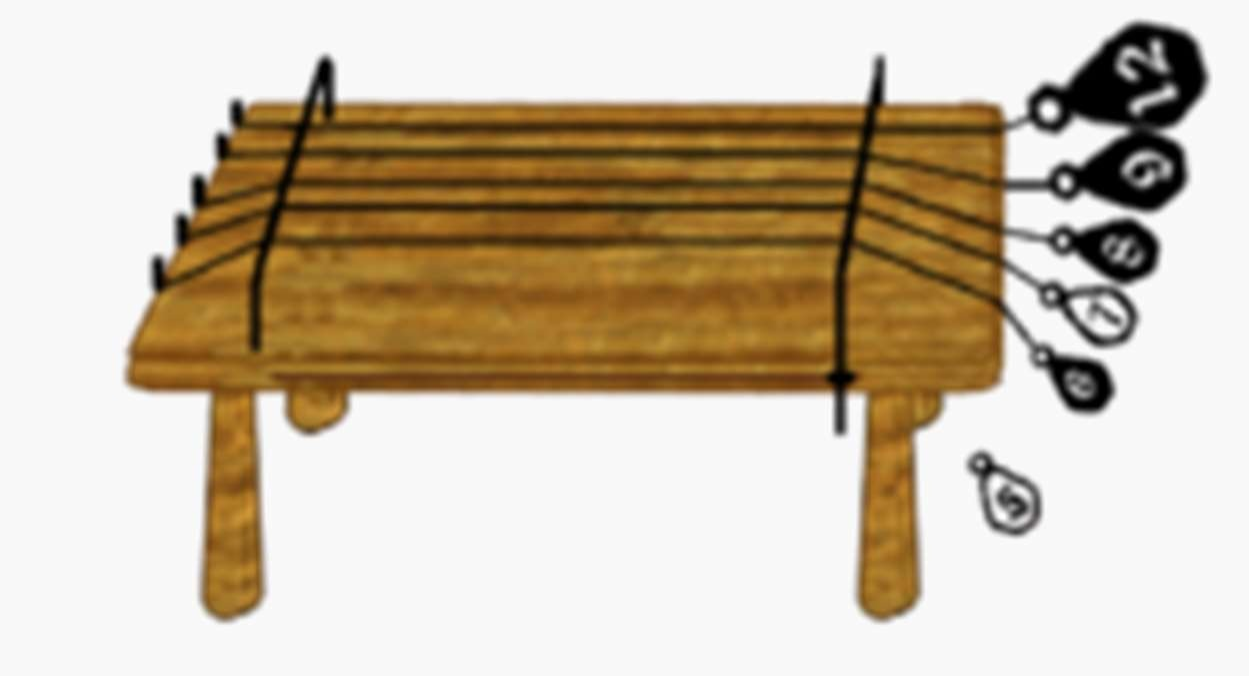
5. Results typical y are available immediately following the procedure. Two score results are possible: a T-score, which compares a patient's scan against that of a young person of the same gender; and a Z-score, which compares the scan against someone of similar age, weight and gender. The T-scores results are used to assess the risk of osteoporosis. A score above -1 indicates a low risk for osteoporosis; below -1 to -2.5 indicates a risk of developing osteoporosis; and a score below 2.5 indicates more intensive testing should be performed and that osteoporosis is likely present. The Z-score reports how much bone the patient has as compared to others his age. If this number is high or low, further testing may be ordered.

6. Women in general, specifical y those older than the age of 65, are at increased risk of developing osteoporosis. Other high risk groups include the elderly, those with a family history of osteoporosis or a personal history of bone fractures and those of Caucasian, Asian and Latino descent. It is vital y important for such groups to be aware of changes in bone density. Osteoporosis is a common problem that can be quickly and simply diagnosed through the use of a clinical bone sonometer. By discovering osteoporosis in its early stages and taking steps to avoid its progression, serious consequences associated with this debilitating condition may be avoided in later years.

Activity -2

Discuss and write the observation on the Experimental use of sonometer.

The monochord can be used to illustrate the mathematical properties of musical pitch and to illustrate Mersenne's laws regarding string length and tension: "essentially a tool for measuring musical intervals".[4] For example, when a monochord's string is open it vibrates at a particular frequency and produces a pitch. When the length of the string is halved,and plucked, it produces a pitch an octave higher and the string vibrates at twice the frequency of the original (2:1) Half of this length will produce a pitch two octaves higher than the original—four times the initial frequency (4:1)—and so on. Standard diatonicPythagorean tuning (Ptolemy's Diatonic Ditonic) is easily derived starting from superparticular ratios, (n+1)/n, constructed from the first four counting numbers,the tetractys, measured out on a monochord.The mathematics involved include the multiplication table, least common multiples, and prime and composite numbers.[4]



Several string "monochord"

"As the name implies, only one string is needed to do the experiments; but, since ancient times, several strings where used, al tuned in exact unison, each with a moveable bridge, so that various intervals can be compared to each other [consonance and dissonance]." A "bichord instrument" is one, "having two strings in unison for each note [acourse]," such as the mandolin.[5] With two strings one can easily demonstrate how various musical intervals sound. Both open strings are tuned to the same pitch, and then the movable bridge is put in a mathematical position on the second string to demonstrate, for instance, the major third (at 4/5th of the string length)

CONCLUSIVE REMARKS-

Sonometer can be used to generate waves of various frequencies differentiating the musical sound from noise.

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USE OF MEDIA IN ENHANCING PHYSICS TEACHING

–Learning Strategies

Introduction about – Using media in Enhancing Teaching –Learning Strategies

When we were in school, a class period (or two!) dedicated to watching a film was definitely a highlight for us as students. Now, my learners consistently request movies or television shows as learning aids, but as an instructor I struggle with how and when to use them in class.

LEARNING OUTCOMES

1. Showing films in the classroom to get the most mileage out of a movie day

How can instructors utilize visual media in a way that enhances rather than interrupts learning? A few key strategies can help ensure that the time invested in movie day is worthwhile.

2. Content to-dos for classroom movies

The focus on the curriculum is essential not just for legal purposes, but to ensure that your movie day contributes to forward momentum in your classroom. The storyline of the movie should enhance or iterate course material. a using visual media that is relevant to the educational questions and larger goals of the classroom.

3. Helping students study films in class: Note-taking, discussion and analysis

Consider what the best use of time is with films and whether teachers wish to show a movie in its entirety, lift specific scenes, or, in the case of teaching

4. it is essential to teach students how to encounter movies as academics rather than simple observers. Strategies he uses to get the most out of classroom films include active listening, note-taking, and occasional interruptions for discussion.

5. “A movie, used strategical y and with accountability pieces, can build inferencing skills, practice identification and analysis of symbols and motifs, and is a natural fit for exploring method, meaning, and so what.” students can be held accountable while they are watching by stopping the film after smal sections and asking students pointed questions about directorial choices and other techniques used in the piece.

6. **Movies can show real-world examples of textbook subjects**

7. Replays the scene, encouraging the students to cal out when they witness something they have studied. The multiple viewings and active engagement with the clip help him avoid what might otherwise be a boring lecture but also helps students see real-world examples of the rather dry textbook definitions they’ve just finished reading about.

8. This strategy always results in a boisterous affair with the students active and engaged with the material. After the experience, students are welcome to discuss any remaining questions or clarifications they need. While my colleague does not show the movie in its entirety, he shared that often his students will watch the full movie at home to prepare for their next in-class clip.

9. movies can play an interesting role in our classrooms, engaging auditory and visual learners in ways that the textbook or discussions cannot. With a little forethought and planning, ful movies and movie clips can become an essential piece of our classrooms, enhancing rather than interrupting learning.

Movie Time -The Prestige

Introduction of

Movie involving magicians revolving around a trick which in itself is the plot.

Finally there is one thing I've never heard anyone mention, but I actually think may be the most interesting part of the movie, and that is the question "If you die, but a clone of you, with all of your memories, continues to live, did you really die?" After al , each clone goes on performing Angier's trick. Every clone

is in every sense Angier, so much so that each one is willing to murder himself out of commitment to the trick. Now

THAT is a pretty awesome concept to be discussing in a major motion picture.

Introduction

“Are you watching closely?” Thus begins Christopher Nolan’s masterful y crafted period piece that seems to have a lot more going on than one might initially see occurring on the surface. This review assumes you’ve already watched The Prestige. If you haven’t – go away. Watch the movie, then come back. Are we clear? Great.

To set the stage for the reveal – I really must quote R.J. Carter, a science fiction author and a Senior Editor of “The Trades”, and how let down he felt upon originally watching the movie:

“So why do I feel cheated?… Because after commit ing so much time and faith to the plot, I find out that the story is one of science fiction. Don’t get me wrong — I love a good science fiction story; just tel me in advance”… “So why do I feel cheated?… Because after commit ing so much time and faith to the plot, I find out that the story is one of science fiction. Don’t get me wrong — I love a good science fiction story; just tel me in advance.”

What Carter doesn’t realize is that he’s only understood the first two epiphanies. It is the third that makes the movie make sense. It is the third that makes the Nolans the most brilliant writers in cinema history. To convince you, here is Newsweeks thoughts on the movie:

“At the end of this dark entertainment three twists await: one you will certainly see coming, another you may have figured out just before it happens, and the final may be so tricky you won’t quite piece it all together until after you’ve left the theater.”

So the chal enge is in front of us. There are THREE surprises awaiting the diligent. Let’s not waste time – we’ve got some discovering to do.

A Prestige Primer

The plot of the Prestige is simple at face value. We are presented with two young aspiring magicians. Angier (played by Hugh Jackman) a very good showman but less than stellar magician. And Borden (played by Christian Bale) a natural magician in every right but a bit dim in the showmanship category. The prime mover of the entire movie’s sadistic tendencies is a tragic event that ends up kil ing Angier’s wife and it is believed Borden is to blame. The two quickly develop a rivalry to end al rivalries reminiscent of the Montigues and Capulets that basically consumes them night and day. It begins with Borden and Angier racing to become the best magician in London and ends with mayhem, blood and death.

Possible Prestige Methods

The point of this review is not to speak to the surface level plot points of the movie, but rather to address a deficit I am seeing in the larger Prestige discussion arena. Many people that have seen the movie and have discussed the various intricacies gravitate more towards the more philosophical and moral nuggets held within. And that is a great discussion to be had – don’t get me wrong – but think al of these discussions completely miss the larger reveal – or Prestige if you will – that is going on here in front of everyone’s noses. So to that end I will first recount the more populist of theories out there that most ascribe (at least in one flavor or another). And then I will sketch out for you my version of how the movie played itself out.

We Have Seen The Populists And We Are Them…

When the dust of this movie set les for most people it is fairly clear, if not a bit disappointing, what happened throughout. But what makes this Populist theory so widespread and overwhelmingly popular is that you have to work to come to this conclusion. Its not a simple thing to understand this movie even at the most basic of levels. So, when most people rearrange the anarchic timeline in their heads and finally makes sense of that they then begin cogitating on the whole “reveal” with Borden and his twin at the finale.

Once they get that bit they progress to the larger questions circulating around Angier and the Tesla machine. At this point the chaos is so thick and the hip-waders are so completely and totally mucked they’l take even some of the more outlandish of answers as fact.

Where the disagreement within this camp lies is usual y within the “How exactly did Tesla make the machine work”, “which Borden was hanged” or the “how many Angiers were there that drowned?” veins. The really adventurous within this camp may posit something as outlandish as – “The Tesla machine isn’t a cloning machine, it’s a teleportation machine that leaves a new clone behind” which creates reams and reams of discussion fodder. So al that to say, this Populist vantage on the movie takes the ending literal y. The Tesla machine clones al those who enter and the only thing left to sort out is how do we dispose of the extras?

The Man Behind the Curtain

The first point I would like to make in regards to this larger reveal within The Prestige would have to be a completely unrelated movie. Anyone who has experienced any of Christopher Nolan’s other movies will know, the Director of The Prestige is not afraid to layer ambiguity over ambiguity in order to create a powerful tapestry that ultimately overloads the senses. Memento is the perfect example of this il usion folded in on top of illusion with the intentional objective of avoiding a definitive answer to the problems played across the screen. The Prestige is yet another example of this, where we are confronted with constantly conflicting evidence that may or may not point in 42 different directions. All that to say, everything I am about to posit here and now was intentionally placed within the Prestige strategical y by Mr. Nolan. I guarantee it. Now, as to whether or not my vantage on this movie is correct or not I will leave this question in your capable hands to ascertain.

What is the third reveal?

Quite simply put I believe that the Tesla machine is a sham and it doesn’t do anything but throw pretty sparks. Already many of you are hefting your rocks in order to stone me for heresy. To understand how I can posit something that contradicts everything we are told as the movie wraps up will take some effort. But if you will stick with me – and then if you watch the movie again – you will see not only how plausible al of this is but how necessary it is for the entire movie to make any sense at all.

The Prestige’s Prestige on AutoPilot

How can it possibly be? Let’s just cut to the chase and I will walk you through the explanation in a timeline format:

1. Angier and Borden work together as plants in a show where Angier’s wife is accidentally kil ed.
2. The two go their separate ways and begin developing their own shows.
3. Borden and Fal on (Borden’s twin) develop the transporting man.
4. Angier becomes obsessed with understanding the trick at al costs.
5. Angier steals Borden’s notebook and realizes it would take him years to decipher.
6. Angier captures Fal on and gives him back after Borden reveals the method/key –“Tesla”.
7. Angier embarks on a trip to Tesla in order to have him build him a teleporting machine.
8. Tesla is tipped by Borden of Angier’s goals and Tesla takes him on a wild goose chase.
9. Angier “discovers” the hats and the cats and is convinced the machine works.
10. Angier receives the machine under dubious circumstances.
11. Angier learns that the machine in fact does not work and realizes he’s been duped.
12. Angier begins plotting his revenge by staging a limited engagement of the new teleporting man.
13. Borden visits both the show and the backstage removal of the tanks.
14. Borden then goes onstage and then down below where he witnesses Angier’s double drowning.
15. Borden is arrested for murder and put on trial.
16. Angier – as Lord Caldlow – stil wants to know Borden’s method and so he at empts to purchase the method for the drowning man from Borden while he’s in prison.
17. Borden receives Angier’s journal and begins learning about Angier’s trip to visit Tesla.
18. Borden discovers that Angier has apparently anticipated Borden’s murder of himself prior.
19. Borden sel s the transporting man trick in trade for his daughter’s safety.

20. Angier visits Borden in prison to make him aware he's won.

21. Borden is hanged – says "Abracadabra" just beforehand.

22. Fallon – now dressed as Borden – goes to Angier in his theater basement and shoots him.

23. Angier attempts to get Borden to notice his surroundings – Borden doesn't bite.

24. Angier dies and Borden is reunited with his daughter.

25. Rol Credits.

Concluding Remark

I have intentional y avoided explaining some of the stickier issues with this theory above. Instead I have differed a few of the more obvious rebut als until later. But first, you have to admit that walking through the movie in its proper chronology along with this new view of how the events unfolded sheds quite a bit of light on certain aspects that you wouldn't have noticed before. For example – why would Angier stil be trying to get Borden's method after having reproduced the trick with the Tesla machine? It logically doesn't follow. He'd been duplicating himself successfully for months – why does he stil need the method?

After watching movie :- Discussions and observations on

The Narration

How can it be that a movie can physically get away with lying to our faces? The first (and maybe the most important exercise) thing we must consider is the source. Can you remember who does the narration of this movie? Yes, you are correct Cutter does narrate a fair amount.But who else narrates the action as it proceeds? No it isn't completely accurate to say either Borden or Angier narrates. Actually if you look closely you'll realize that the two key narrators in this story are Borden's diary read by Angier and alternately Angier's diary being read by Borden.

The next question that we must ask ourselves is this – can we trust Borden's or Angier's diaries? Obviously not. One of the greater sub-plot twists is the reveal to Borden that Angier is writing to him "from the dead". Similarly, we feel Angier's unfet ered angst and loathing for Borden when Borden's diary reveals that the entire document was crafted solely for his consumption. So, if this is the case, why should we believe a single thing that these sources have revealed to us? Right, so please keep that in mind as we continue forward.

The Motivations

If we consider both of the two main characters, Borden and Angier, what would we say that their main motivations are? For Borden I think it is fairly obvious that he is intent on developing the world's best magic trick that will turn the world upside down. You recal his arguments on behalf of the bullet catch and his hopes for doing something new and exciting as opposed to the litany of tried and true tricks. Angier on the other hand feeds off of the love and approval only the audience can give. One of the really great threads buried deep within this movie is the juxtaposition of these two extremes. Natural talent and savant versus the ever envious showman. These two men obviously are out for blood and nothing is going to stand in their way.

Early on Borden discovers a key fact about what it means to truly become a great magician/artist. Borden understood that it took complete dedication to his craft 24/7/365 days of the year. There was no on-stage moment… his life was the stage. But what has this to do with the final reveal? Angier finally understands that to best Borden he is going to have to get his hands dirty. He is going to invest sizably and go to extraordinary lengths to better Borden. And in Angier's defense, this he does really really well. Angier is solely responsible for this the most extraordinary of surprises in al of the movie. He has finally learned the lesson Borden has been trying to teach him for years. And it is this lesson, this surprise that 98% of the movie's audience are blissfully unaware.

Wild Theories

Revisiting The Prestige, the ending struck me as clear cut, as far as Nolan's conclusions go.There wasn't a lot of room for interpretation, and the reveal of the Angier body in the floating tank of water was just confirmation that the il usionist was "kil ing" himself night after night, but creating a fresh clone who would live until the next performance.

of course, as Cutter says in the final bit of narration:

> Now, you're looking for the secret. But you won't find it because, of course, you're not really looking. You don't really want to work it out. You want to be fooled.

So, I dug around. And I tumbled down a spectacular Reddit hole of alternate theories. Fans of the film raised a lot of fantastic questions and points that film either doesn't address, or doesn't answer well enough. For example, if Angier really wants to perfect The Disappearing Man, why doesn't he just clone himself once, use the clone in the trick night after night, and never have to drown anyone? There's the fact that Angier dies symbolically this way because it's how his wife died. And Cutter has a line where he told Angier how drowning was like "going home," only Cutter lately reveals that he was lying. That dialogue is in the movie for a reason. Stil , without a natural twin, Angier could have cloned himself once, then performed the trick from now until infinity with Borden never being the wiser. However, that would mean he never could have framed Borden for "murder."

Another prevalent theory online states that Tesla's machine never worked, and that he was stringing the wealthy Angier along so he could fund his next project. When the government got too close to Tesla, the inventor left, leaving Angier with a broken machine. Those who follow that thread point out that Angier's "clones" should have had the same limp that the Angier Prime had, from a brutal fal earlier in the film. There are a surprising amount of people who believe that the real trick to The Prestigeis making the audience believe that a machine capable of cloning another human actually exists.

The prime mover of the movie-*The Prestige's*

1.The very first prime mover we encounter within the movie is that magic is special in that it frees the audience from their painful and boring lives by allowing them to believe in something that is unreal. It frees them to believe in something greater, that something truly otherworldly exists in this world. Why would we not begin to think for a second that the movie The Prestige is doing anything differently? It is then allowing the audience to slip into the fantastical notion that magic is real and there is an escape from the ordinariness of this life. When in fact there really is a solution available to those who are diligent and observant.

2.Secondly throughout the movie we are shown time and time again the details of various magic tricks and how they physical y work. Then at the end al of a sudden this pattern stops and the machine actual y works? This answer is disjointed in the extreme. If this occurred in The Illusionist I wouldn't have given it a second thought.But it didn't… it occurred in The Prestige and it in so doing is a logical fal acy.

3.And finally, the movie proves its on thesis in that most don't really want to know how a magic trick is done. We really do want to be fooled. So to it goes with the mechanics of how the movie actually works. Most do not want to be fooled. Ask yourself this question. Is The Prestige a drama or a science fiction movie? It doesn't logically follow that it would be a science fiction movie. It makes no sense that a writer/director as smart as Christopher Nolan would make this mistake accidentally.Its way too brazen and obvious for such a nuanced and intel igent director.

After watching movie Discuss the following questions in groups:

1. What do you believe?
2. Is there a deeper twist at the end of The Prestige that we aren't seeing?
3. Or did Christopher Nolan leave his cards on the table this time, for al to see?
4. Weigh in below with your best guess and wild theories.
5. Discuss the critical analysis/ responses.

Series : SKS/1

कोड नं.
Code No. 55/1/1

रोल नं.
Roll No.

परीक्षार्थी कोड को उत्तर-पुस्तिका के मुख-पृष्ठ पर अवश्य लिखें ।
Candidates must write the Code on the title page of the answer-book.

- कृपया जाँच कर लें कि इस प्रश्न-पत्र में मुद्रित पृष्ठ **15** हैं ।
- प्रश्न-पत्र में दाहिने हाथ की ओर दिए गए कोड नम्बर को छात्र उत्तर-पुस्तिका के मुख-पृष्ठ पर लिखें ।
- कृपया जाँच कर लें कि इस प्रश्न-पत्र में **29** प्रश्न हैं ।
- **कृपया प्रश्न का उत्तर लिखना शुरू करने से पहले, प्रश्न का क्रमांक अवश्य लिखें ।**
- इस प्रश्न-पत्र को पढ़ने के लिए 15 मिनट का समय दिया गया है । प्रश्न-पत्र का वितरण पूर्वाह्न में 10.15 बजे किया जायेगा । 10.15 बजे से 10.30 बजे तक छात्र केवल प्रश्न-पत्र को पढ़ेंगे और इस अवधि के दौरान वे उत्तर-पुस्तिका पर कोई उत्तर नहीं लिखेंगे ।
- Please check that this question paper contains **15** printed pages.
- Code number given on the right hand side of the question paper should be written on the title page of the answer-book by the candidate.
- Please check that this question paper contains **29** questions.
- **Please write down the Serial Number of the question before attempting it.**
- 15 minutes time has been allotted to read this question paper. The question paper will be distributed at 10.15 a.m. From 10.15 a.m. to 10.30 a.m., the students will read the question paper only and will not write any answer on the answer-book during this period.

भौतिक विज्ञान (सैद्धान्तिक)

PHYSICS (Theory)

निर्धारित समय : 3 घंटे] *[अधिकतम अंक : 70*

Time allowed : 3 hours] *[Maximum Marks : 70*

सामान्य निर्देश :

(i) ***सभी** प्रश्न अनिवार्य हैं ।*

(ii) *इस प्रश्न-पत्र में कुल **29** प्रश्न हैं । प्रश्न **1** से **8** तक के प्रश्न अति-लघुउत्तरीय प्रश्न हैं और प्रत्येक **एक** अंक का है ।*

(iii) *प्रश्न **9** से **16** में प्रत्येक प्रश्न **दो** अंक का है, प्रश्न **17** से **25** में प्रत्येक प्रश्न **तीन** अंक का है तथा प्रश्न **27** से **29** में प्रत्येक प्रश्न **पाँच** अंक का है ।*

(iv) *प्रश्न-पत्र में समग्र पर कोई विकल्प नहीं है । तथापि, **दो** अंकों वाले एक प्रश्न में, **तीन** अंकों वाले एक प्रश्न में और **पाँच** अंकों वाले तीनों प्रश्नों में आन्तरिक चयन प्रदान किया गया है । ऐसे प्रश्नों में आपको दिये गये चयन में से केवल **एक** प्रश्न ही करना है ।*

(v) *प्रश्न **26** मूल्य आधारित प्रश्न है । यह **चार** अंक का है ।*

(vi) *कैलकुलेटर के उपयोग की अनुमति **नहीं** है । तथापि यदि आवश्यक हो तो आप लघुगणकीय सारणी का प्रयोग कर सकते हैं ।*

(vii) *जहाँ आवश्यक हो आप निम्नलिखित भौतिक नियतांकों के मानों का उपयोग कर सकते हैं :*

$c = 3 \times 10^8$ m/s

$h = 6.63 \times 10^{-34}$ Js

$e = 1.6 \times 10^{-19}$ C

$\mu_o = 4\pi \times 10^{-7}$ T m A^{-1}

$\frac{1}{4\pi\varepsilon_o} = 9 \times 10^9$ N m^2 C^{-2}

$m_e = 9.1 \times 10^{-31}$ kg

Mass of the Neutron = 1.675×10^{-27} kg

Mass of the Proton = 1.673×10^{-27} kg

General Instructions :

(i) ***All** questions are compulsory.*

(ii) *There are **29** questions in total. Question Nos. **1** to **8** are very short answer type questions and carry **one** mark each.*

(iii) *Question Nos. **9** to **16** carry **two** marks each, Question Nos. **17** to **25** carry **three** marks each and Question Nos. **27** to **29** carry **five** marks each.*

(iv) *There is no overall choice. However, an internal choice has been provided in **one** question of **two** marks, **one** question of **three** marks and all **three** questions of **five** marks each. You have to attempt only **one** of the choices in such questions.*

(v) *Question No. **26** is value based question carries **four** marks.*

(vi) *Use of calculators is not permitted. However, you may use log tables if necessary.*

(vii) *You may use the following values of physical constants wherever necessary :*

$c = 3 \times 10^8$ m/s

$h = 6.63 \times 10^{-34}$ Js

$e = 1.6 \times 10^{-19}$ C

$\mu_o = 4\pi \times 10^{-7}$ T m A^{-1}

$\frac{1}{4\pi\varepsilon_o} = 9 \times 10^9$ N m^2 C^{-2}

$m_e = 9.1 \times 10^{-31}$ kg

Mass of the Neutron = 1.675×10^{-27} kg

Mass of the Proton = 1.673×10^{-27} kg

1. स्थायी चुम्बकों से क्या तात्पर्य है ? एक उदाहरण दीजिये ।

What are permanent magnets ? Give one example.

2. एक अकेले विलगित आवेशित के समविभव पृष्ठ की ज्यामितीय आकृति कैसी होती है ?

What is the geometrical shape of equipotential surfaces due to a single isolated charge ?

3. निम्नांकित में से किन तरंगों का ध्रुवण हो सकता है ?

(i) ऊष्मा तरंगें

(ii) ध्वनि तरंगें

अपने उत्तर के समर्थन में कारण दीजिए ।

Which of the following waves can be polarized (i) Heat waves (ii) Sound waves ? Give reason to support your answer.

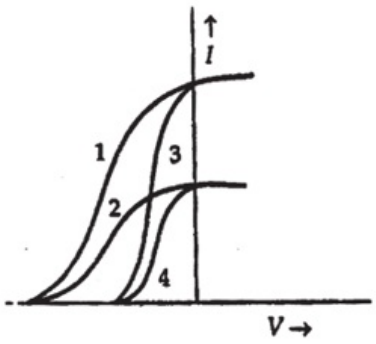
4. एक संधारित्र को डी.सी. (d.c.) स्रोत द्वारा आवेशित किया गया है । इसके पूर्णत: आवेशित होने पर चालन धारा तथा विस्थापन धारा का मान क्या होगा ?

A capacitor has been charged by a dc source. What are the magnitudes of conduction and displacement currents, when it is fully charged ?

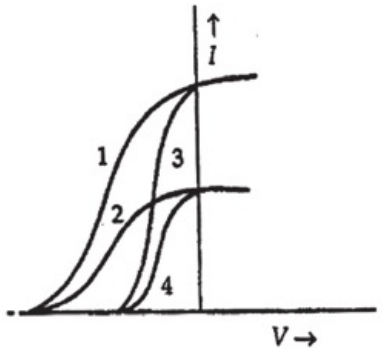
5. किसी त्रिकोणी प्रिज़्म में, आपतन कोण 'i', प्रिज़्म के कोण 'A' तथा न्यूनतम विचलन कोण में संबंध लिखिये ।

Write the relationship between angle of incidence 'i', angle of prism 'A' and angle of minimum deviation for a triangular prism.

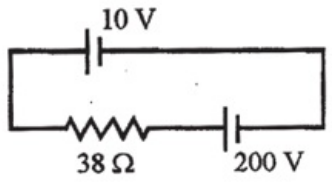
6. दिया गया ग्राफ (आलेख), दो विभिन्न प्रकाश-संवेदी पदार्थों तथा आपतित विकिरणों की दो भिन्न-भिन्न आवृत्तियों के लिये, अनुप्रयुक्त विभवता (V) के साथ प्रकाश विद्युत धारा (I) के परिवर्तन (विचरण) को दर्शाता है । वक्रों के उन युग्मों की पहचान कीजिये जो भिन्न (अलग) पदार्थ किन्तु आपतित विकिरणों की समान (एक ही) तीव्रता के संगत हैं ।



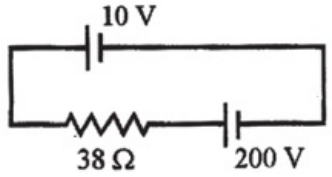
The given graph shows the variation of photo-electric current (I) versus applied voltage (V) for two different photosensitive materials and for two different intensities of the incident radiation. Identify the pairs of curves that correspond to different materials but same intensity of incident radiation.



7. नगण्य आन्तरिक प्रतिरोध की 10 V की एक बैटरी को, एक 38 Ω के प्रतिरोधक तथा 200 V की एक अन्य बैटरी से आरेख में दर्शाये गये अनुसार संयोजित किया गया है । परिपथ में विद्युत धारा का मान ज्ञात कीजिये ।



A 10 V battery of negligible internal resistance is connected across a 200 V battery and a resistance of 38 Ω as shown in the figure. Find the value of the current in circuit.



8. किसी सेल का विद्युत वाहक बल (e.m.f.) सदैव उसके टर्मिनलों के बीच विभवान्तर से अधिक होता है। इसका कारण लिखिये ।

The emf of a cell is always greater than its terminal voltage. Why ? Give reason.

9. (a) पूर्ण आन्तरिक परावर्तन की परिघटना के लिये आवश्यक प्रतिबंधों (शर्तों) का उल्लेख कीजिये ।

(b) प्रकाशीय माध्यमों के किसी एक युग्म के लिये अपवर्तनांक तथा क्रांतिक कोण के बीच संबंध लिखिये ।

(a) Write the necessary conditions for the phenomenon of total internal reflection to occur.

(b) Write the relation between the refractive index and critical angle for a given pair of optical media.

10. लेंज नियम को लिखिये ।

पूर्व-पश्चिम दिशा में क्षैतिज रखी धातु की एक छड़ को मुक्त रूप से गुरुत्वाधीन गिराया जाता है । क्या इसके सिरों के बीच विद्युत वाहक बल (e.m.f.) प्रेरित होगा ? अपने उत्तर के समर्थन में कारण लिखिये ।

State Lenz's Law.

A metallic rod held horizontally along east-west direction, is allowed to fall under gravity. Will there be an emf induced at its ends ? Justify your answer.

11. 25 cm फोकस दूरी के एक उत्तल लेंस तथा 20 cm दूरी के एक अवतल लेंस को समाक्षी सम्पर्क में रखा गया है । इस संयोजन की शक्ति ज्ञात कीजिये । यह संयोजन अभिसारी होगा या अपसारी ?

A convex lens of focal length 25 cm is placed coaxially in contact with a concave lens of focal length 20 cm. Determine the power of the combination. Will the system be converging or diverging in nature ?

12. एक ऐमीटर का प्रतिरोध 0.80 Ω है और यह 1.0 A तक की विद्युत धारा को माप सकता है । तो

(i) इस ऐमीटर से 5.0 A तक की विद्युत धारा मापने के लिये कितने प्रतिरोध के शन्ट की आवश्यकता होगी ?

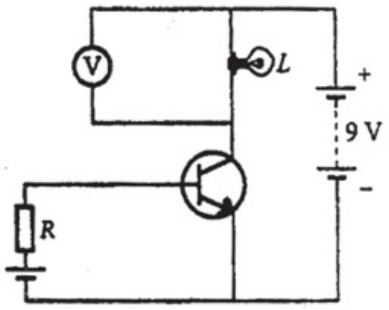
(ii) इस ऐमीटर तथा शन्ट का संयुक्त प्रतिरोध कितना होगा ?

An ammeter of resistance 0.80 Ω can measure current upto 1.0 A.

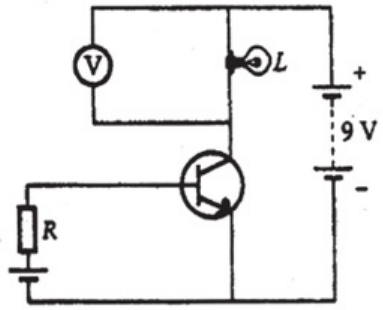
(i) What must be the value of shunt resistance to enable the ammeter to measure current upto 5.0 A ?

(ii) What is the combined resistance of the ammeter and the shunt ?

13. दिये गये परिपथ में एक वोल्टमीटर (V) को एक विद्युत बल्ब (L) के सिरों से जोड़ा गया है । यदि परिपथ में प्रतिरोध R का मान कम कर दिया जाय तो, (i) बल्ब L की दीप्ति (चमक) पर, तथा (ii) वोल्टमीटर 'V' के पठन (रीडिंग) पर क्या प्रभाव पड़ेगा ? अपने उत्तर के समर्थन में कारण लिखिये ।



In the given circuit diagram, a voltmeter 'V' is connected across a lamp 'L'. How would (i) the brightness of the lamp and (ii) voltmeter reading 'V' be affected, if the value of resistance 'R' is decreased ? Justify your answer.



14. (a) एक विद्युत चुम्बकीय तरंग किसी माध्यम में $\vec{v} = v\,\hat{i}$, वेग से गमन करती है । इस तरंग के संचरण को दर्शाने के लिये एक रेखाचित्र बनाइये जिसमें दोलनीय विद्युत तथा चुम्बकीय क्षेत्रों को निर्दिशित किया (दर्शाया) गया हो ।

(b) विद्युत तथा चुम्बकीय क्षेत्र के परिमाण विद्युत चुम्बकीय तरंगों के वेग से किस प्रकार सम्बन्धित हैं ?

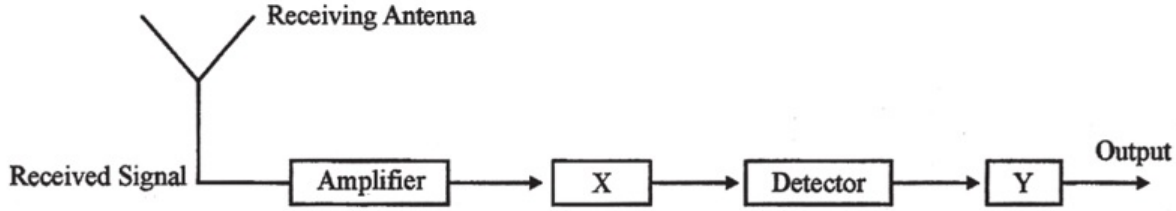
(a) An em wave is travelling in a medium with a velocity $\vec{v} = v\,\hat{i}$. Draw a sketch showing the propagation of the em wave, indicating the direction of the oscillating electric and magnetic fields.

(b) How are the magnitudes of the electric and magnetic fields related to the velocity of the em wave ?

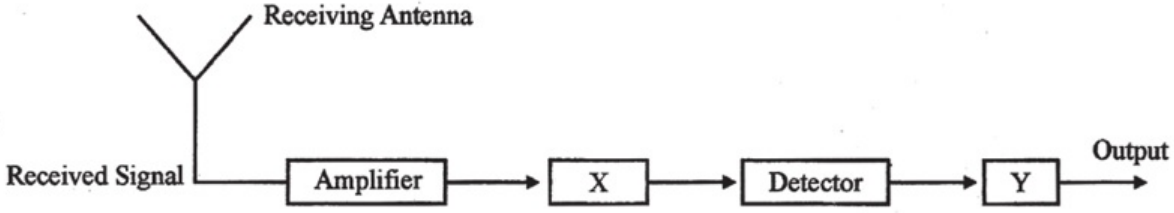
15. यहाँ किसी अभिग्राही (रिसीवर) का एक ब्लॉक आरेख दर्शाया गया है । इसमें,

(a) 'X' तथा 'Y' को पहचान कर उनके नाम लिखिये ।

(b) 'X' तथा 'Y' के कार्य (प्रकार्य) लिखिये ।



Block diagram of a receiver is shown in the figure :



(a) Identify 'X' and 'Y'.

(b) Write their functions.

16. एक परिपथ आरेख की सहायता से किसी फोटो डायोड की कार्यप्रणाली को स्पष्ट कीजिये । संक्षेप में लिखिये कि यह प्रकाशीय संकेतों (सिग्नलों) का संसूचन कैसे करता है ।

अथवा

यदि किसी p-n (पी.एन.) संधि डायोड का प्रकाश उत्सर्जक डायोड (LED) की भाँति उपयोग करना हो, तो इसके निर्माण में किन महत्वपूर्ण आवश्यकताओं का ध्यान रखना होता है ? उल्लेख कीज़िये । यदि किसी LED को दृश्य-परिसर में प्रकाश उत्सर्जित करने के लिये बनाया जाना है, तो बैंड-अन्तराल (गैप) की कोटि का मान कितना होना चाहिये ?

Explain, with the help of a circuit diagram, the working of a photo-diode. Write briefly how it is used to detect the optical signals.

OR

Mention the important considerations required while fabricating a p-n junction diode to be used as a Light Emitting Diode (LED). What should be the order of band gap of an LED if it is required to emit light in the visible range ?

17. एक संदेश संकेतों को मॉडुलित करने की आवश्यकता का समर्थन करने वाले तीन महत्त्वपूर्ण कारक लिखिए । जब मॉडुलित संकेत वाहक तरंगों पर अध्यारोपित होते हैं तो आयाम मॉडुलित तरंग किस प्रकार प्राप्त होते हैं ? आकृति सहित समझाइए ।

Write three important factors which justify the need of modulating a message signal. Show diagrammatically how an amplitude modulated wave is obtained when a modulating signal is superimposed on a carrier wave.

18. अज्ञात धारिता के किसी संधारित्र को V वोल्ट की एक बैटरी के सिरों से जोड़ा गया है । संधारित्र में संचित आवेश 360 μC है । संधारित्र के सिरों के बीच विभव को 120 V कम करने पर उसमें आवेशित आवेश 120 μC हो जाता है, तो परिकलन कीजिये,

(i) विभव V तथा संधारित्र की अज्ञात धारिता C

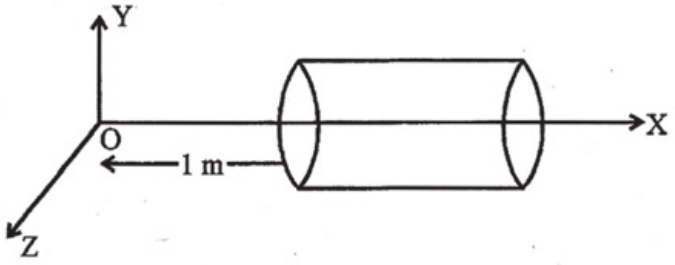
(ii) संधारित्र में संचित आवेश की मात्रा यदि अनुप्रयुक्त वोल्टता में 120 V की वृद्धि की गई होती ।

अथवा

एक खोखले बेलनाकार सन्दूक (बॉक्स) की लम्बाई 1 m है । इसकी अनुप्रस्थ काट का क्षेत्रफल 25 cm^2 है । इसको आरेख में दर्शाये गये अनुसार एक त्रि-आयामी निर्देशांक निकाय में रखा गया है । इस प्रदेश में विद्युत क्षेत्र को $\vec{E} = 50\, x\hat{i}$, से निरूपित किया जाता है । जहाँ E का मान NC^{-1} में तथा x का मीटर (m) में है । तो, ज्ञात कीजिये :

(i) बेलनाकार सन्दूक से गुज़रने वाला नेट फ्लक्स तथा

(ii) बेलनाकार सन्दूक द्वारा परिबद्ध आवेश



A capacitor of unknown capacitance is connected across a battery of V volts. The charge stored in it is 360 μC. When potential across the capacitor is reduced by 120 V, the charge stored in it becomes 120 μC.

Calculate :

(i) The potential V and the unknown capacitance C.

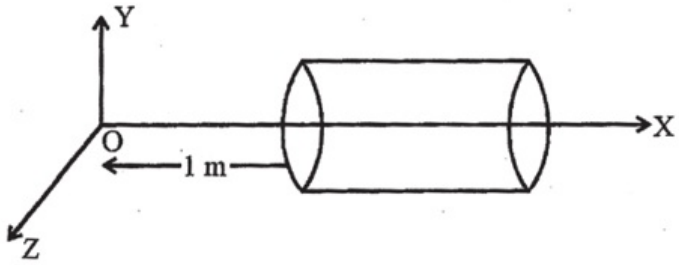
(ii) What will be the charge stored in the capacitor, if the voltage applied had increased by 120 V ?

OR

A hollow cylindrical box of length 1 m and area of cross-section 25 cm^2 is placed in a three dimensional coordinate system as shown in the figure. The electric field in the region is given by $\vec{E} = 50\, x\hat{i}$, where E is in NC^{-1} and x is in metres. Find

(i) Net flux through the cylinder.

(ii) Charge enclosed by the cylinder.



19. (a) किसी प्ररूपी नाभिकीय प्रक्रिया में, जैसे

$${}_1^2H + {}_1^2H \longrightarrow {}_2^3He + n + 3.27\ MeV,$$ में

यद्यपि न्यूक्लियनों की संख्या संरक्षित रहती है, फिर भी ऊर्जा निर्मुक्त होती है । कैसे ? स्पष्ट कीजिये ।

(b) दर्शाइये कि किसी दिये गये नाभिक में नाभिकीय घनत्व, उसकी द्रव्यमान संख्या A पर निर्भर नहीं होता है ।

(a) In a typical nuclear reaction, e.g.

$${}_1^2H + {}_1^2H \longrightarrow {}_2^3He + n + 3.27\ MeV,$$

although number of nucleons is conserved, yet energy is released. How ? Explain.

(b) Show that nuclear density in a given nucleus is independent of mass number A.

20. (a) प्रकाश विद्युत प्रभाव का स्पष्टीकरण प्रकाश की तरंग प्रकृति के आधार पर क्यों नहीं किया जा सकता है ? कारण लिखिये ।

(b) विद्युत चुम्बकीय तरंगों के फोटॉन-चित्र के उन मूल विशेषताओं को लिखिये जिन पर आइन्स्टाइन का प्रकाश विद्युत समीकरण आधारित है ।

(a) Why photoelectric effect can not be explained on the basis of wave nature of light ? Give reasons.

(b) Write the basic features of photon picture of electromagnetic radiation on which Einstein's photoelectric equation is based.

21. धातु की एक छड़ की लम्बाई 'l' है । इसका एक सिरा, r त्रिज्या के धातु के एक छल्ले (रिंग) के केन्द्र पर कीलित (हिन्ज) है और दूसरा सिरा छल्ले की परिधि पर टिका है । इस छड़ को 'ν' आवृत्ति से इस प्रकार घुमाया (घूर्णन) किया जाता है कि घूर्णन अक्ष छल्ले के केन्द्र से गुज़रती है और छल्ले के समतल के लम्बवत् है । एक स्थिर एकसमान चुम्बकीय क्षेत्र B, जो अक्ष के समान्तर है, सर्वत्र विद्यमान है । लॉरेंज बल के उपयोग से स्पष्ट कीजिये कि, छल्ले तथा उसके केन्द्र के बीच विद्युत वाहक बल (emf) कैसे प्रेरित होता है, और इसके लिये एक व्यंजक प्राप्त कीजिये ।

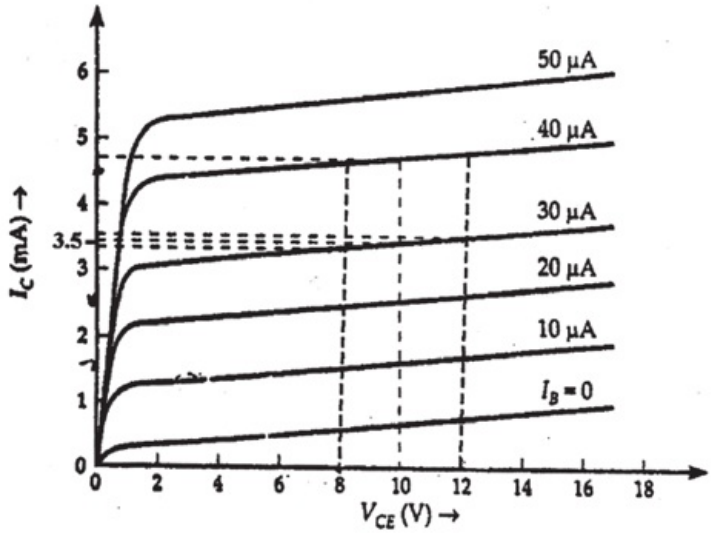
A metallic rod of length 'l' is rotated with a frequency ν with one end hinged at the centre and the other end at the circumference of a circular metallic ring of radius r, about an axis passing through the centre and perpendicular to the plane of the ring. A constant uniform magnetic field B parallel to the axis is present every where. Using Lorentz force, explain how emf is induced between the centre and the metallic ring and hence obtain the expression for it.

22. दिये गये आरेख में किसी n-p-n ट्रांजिस्टर के CE विन्यास में निर्गत अभिलाक्षणिक वक्र दर्शाये गये हैं । इनसे ज्ञात कीजिये :

(i) गतिक निर्गत प्रतिरोध

(ii) dc (डी.सी.) धारा लब्धि तथा

(iii) ac (ए.सी.) धारा लब्धि, जबकि प्रचालन बिन्दु $V_{CE} = 10$ V है, जब $I_B = 30\ \mu A$.

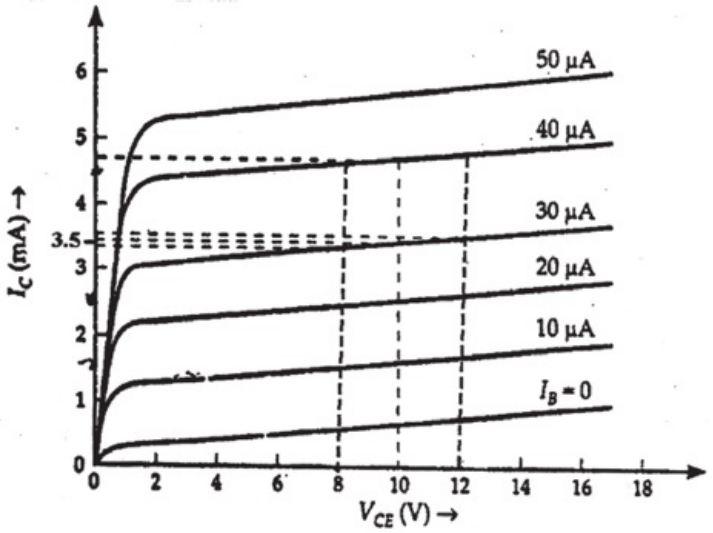


Output characteristics of an n-p-n transistor in CE configuration is shown in the figure. Determine :

(i) dynamic output resistance

(ii) dc current gain and

(iii) ac current gain at an operating point $V_{CE} = 10$ V, when $I_B = 30\ \mu A$.



23. बोर के अभिगृहितों के उपयोग से हाइड्रोजन परमाणु का स्थायी स्थितियों में इलेक्ट्रॉन की कुल ऊर्जा के लिये एक व्यंजक प्राप्त कीजिये । इससे ऊर्जा स्तर आरेख बनाइये जो यह दर्शाये कि ऊर्जा स्तरों के बीच संक्रमणों से बामर श्रेणी के संगत लाइन स्पेक्ट्रम कैसे बनता है ।

Using Bohr's postulates, obtain the expression for the total energy of the electron in the stationary states of the hydrogen atom. Hence draw the energy level diagram showing how the line spectra corresponding to Balmer series occur due to transition between energy levels.

24. (a) द्विझिरी प्रयोग में, दोनों झिरियों से विवर्तन, इस प्रयोग में प्राप्त व्यतिकरण पैटर्न से किस प्रकार संबंधित है ?

(b) सोडियम प्रकाश की दो तरंगदैर्ध्यों, 590 nm तथा 596 nm का उपयोग बारी-बारी से 2×10^{-4} m चौड़ाई की एक एकल झिरी से विवर्तन का अध्ययन करने के लिये किया जाता है । झिरी और पर्दे के बीच की दूरी 1.5 m है । इन दो तरंगदैर्ध्यों से प्राप्त विवर्तन पैटर्नों में प्रथम उच्चिष्ठों की स्थितियों के बीच की दूरी का परिकलन कीजिये ।

(a) In what way is diffraction from each slit related to the interference pattern in a double slit experiment ?

(b) Two wavelengths of sodium light 590 nm and 596 nm are used, in turn, to study the diffraction taking place at a single slit of aperture 2×10^{-4} m. The distance between the slit and the screen is 1.5 m. Calculate the separation between the positions of the first maxima of the diffraction pattern obtained in the two cases.

25. एक श्रेणी LCR परिपथ को, $v = v_m \sin \omega t$ द्वारा निरूपित, परिवर्तनीय आवृत्ति तथा वोल्टता के एक ac (ए.सी.) स्रोत से संयोजित किया गया है । प्रतिरोध R के दो मानों R_1 तथा R_2 ($R_1 > R_2$) के लिये, कोणीय आवृत्ति (ω) के साथ धारा (I) के परिवर्तन (विचलन) को दर्शाने के लिये एक ग्राफ (आलेख) बनाइये । उन शर्तों का उल्लेख कीजिये जिनके अन्तर्गत अनुनाद संभव होता है । दो वक्रों में से प्रतिरोध के किस मान का तीक्ष्ण अनुनाद उत्पन्न करेगा ? परिपथ के गुणवत्ता गुणांक Q की परिभाषा लिखिये तथा इसके महत्त्व का उल्लेख कीजिये ।

In a series LCR circuit connected to an ac source of variable frequency and voltage $v = v_m \sin \omega t$, draw a plot showing the variation of current (I) with angular frequency (ω) for two different values of resistance R_1 and R_2 ($R_1 > R_2$). Write the condition under which the phenomenon of resonance occurs. For which value of the resistance out of the two curves, a sharper resonance is produced ? Define Q-factor of the circuit and give its significance.

26. कार से अपने घर वापस आते समय डॉक्टर पाठक एक तड़ित्-झंझा (तूफ़ान) में फँस गये । बहुत अँधेरा हो गया । उन्होंने कार रोक दी और तूफ़ान के रुकने की प्रतीक्षा करने लगे । एकाएक उन्होंने एक बालक को सड़क पर अकेले चलते देखा । डॉक्टर पाठक ने तूफ़ान रुकने तक बालक को अपनी कार में बिठा लिया और फिर उसे उसके घर तक पहुँचाया । बालक के आग्रह पर डॉक्टर पाठक बालक के माता-पिता से मिले, जिन्होंने बालक की सुरक्षा के प्रति डॉक्टर पाठक की चिन्ता के लिये उनका आभार व्यक्त किया ।

उपरोक्त सूचना के आधार पर निम्नांकित प्रश्नों के उत्तर दीजिये :

(a) तड़ित्-झंझा (तूफ़ान) के समय कार के भीतर बैठे रहना अधिक सुरक्षित क्यों होता है ?

(b) अपने कार्य से डॉक्टर पाठक ने किन दो मूल्यों का प्रदर्शन किया ?

(c) डॉक्टर पाठक के कार्य के संबंध में बालक के माता-पिता की प्रतिक्रिया से उनके कौन से मूल्य प्रतिबिम्बित होते हैं ?

(d) अपने दैनिक जीवन में स्वयं द्वारा पहले कभी किये गये ऐसे ही किसी कार्य का उदाहरण दीजिये ।

(a) किसी संयुक्त सूक्ष्मदर्शी द्वारा प्रतिबिम्ब का बनना दर्शाने के लिये एक किरण आरेख बनाइये । इससे इस सूक्ष्मदर्शी द्वारा प्राप्त कुल आवर्धन के लिये एक व्यंजक प्राप्त कीजिये, यदि अन्तिम प्रतिबिम्ब अनन्तता पर बना हो ।

(b) निकटदृष्टि एवं दीर्घदृष्टि में विभेद कीजिए । आरेखीय रूप से दर्शाइए कि इन दोषों को कैसे दूर किया जा सकता है ।

अथवा

(a) हाइगेन्स का सिद्धान्त लिखिये । इस सिद्धान्त का उपयोग करते हुए, यह दर्शाने के लिये एक आरेख बनाइये कि, दो माध्यमों के अन्तरापृष्ठ पर आपतित कोई समतल तरंगाग्र जब विरल माध्यम से सघन माध्यम को संचरित होता है तो वह किस प्रकार अपवर्तित होता है । इससे अपवर्तन के स्नैल के नियम का सत्यापन कीजिये ।

(b) जब एकवर्णी प्रकाश विरल माध्यम से सघन माध्यम में प्रवेश करता है तो निम्नलिखित प्रश्नों का कारण सहित उत्तर लिखिये :

(i) क्या परावर्तित व अपवर्तित प्रकाश की आवृत्ति वही होती है जो आपतित प्रकाश की है ?

(ii) क्या सघन माध्यम में प्रकाश की चाल में कमी से यह परिणाम प्राप्त होता है कि प्रकाश तरंगों की ऊर्जा में कमी हो जाती है ?

(a) Draw a ray diagram showing the image formation by a compound microscope. Hence obtain expression for total magnification when the image is formed at infinity.

(b) Distinguish between myopia and hypermetropia. Show diagrammatically how these defects can be corrected.

OR

While travelling back to his residence in the car, Dr. Pathak was caught up in a thunderstorm. It became very dark. He stopped driving the car and waited for thunderstorm to stop. Suddenly he noticed a child walking alone on the road. He asked the boy to come inside the car till the thunderstorm stopped. Dr. Pathak dropped the boy at his residence. The boy insisted that Dr. Pathak should meet his parents. The parents expressed their gratitude to Dr. Pathak for his concern for safety of the child.

Answer the following questions based on the above information :

(a) Why is it safer to sit inside a car during a thunderstorm ?

(b) Which two values are displayed by Dr. Pathak in his actions ?

(c) Which values are reflected in parents' response to Dr. Pathak ?

(d) Give an example of a similar action on your part in the past from everyday life.

(a) State Huygen's principle. Using this principle draw a diagram to show how a plane wave front incident at the interface of the two media gets refracted when it propagates from a rarer to a denser medium. Hence verify Snell's law of refraction.

(b) When monochromatic light travels from a rarer to a denser medium, explain the following, giving reasons :

(i) Is the frequency of reflected and refracted light same as the frequency of incident light ?

(ii) Does the decrease in speed imply a reduction in the energy carried by light wave ?

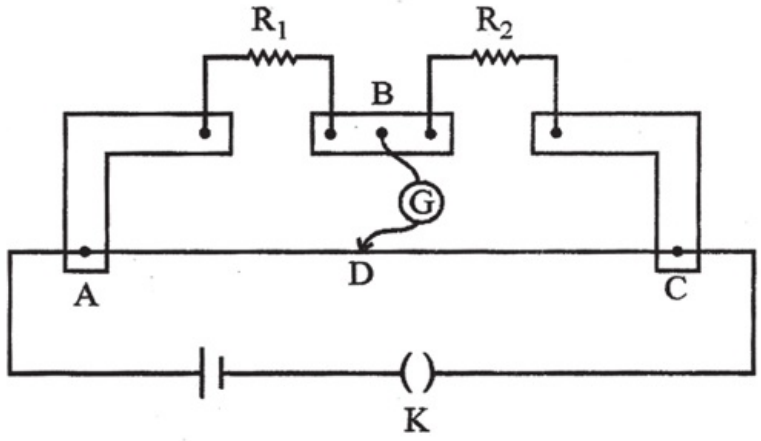
(a) पोटेंशियोमीटर (विभवमापी) का कार्यकारी सिद्धान्त क्या है ? उल्लेख कीजिये । एक परिपथ आरेख की सहायता से स्पष्ट कीजिये कि पोटेंशियोमीटर का उपयोग दो सैलों के विद्युत वाहक बलों (emf) की तुलना के लिये कैसे किया जाता है । इसके लिये आवश्यक व्यंजक को प्राप्त कीजिये ।

(b) पोटेंशियोमीटर के प्रयोगों में केवल एक ही दिशा में विक्षेप होने के दो संभावित कारण लिखिये ।

अथवा

(a) किसी विद्युत परिपथ नेटवर्क के लिये किरचोफ़ के नियम लिखिये । व्हीटस्टोन ब्रिज की चार भुजाओं के प्रतिरोधों के पदों में उसके संतुलन के लिये शर्तें प्राप्त कीजिये ।

(b) मीटर ब्रिज के एक प्रयोग के लिये आरेख में दर्शाये गये व्यवस्थापन में, अविक्षेप बिन्दु, मीटर ब्रिज के तार के सिरे A से 40 cm दूरी पर, बिन्दु 'D' पर प्राप्त होता है । यदि प्रतिरोध R_1 से श्रेणीक्रम में 10 Ω का एक प्रतिरोधक जोड़ दिया जाता है, तो अविक्षेप बिन्दु AD = 60 cm पर प्राप्त होता है । तो R_1 तथा R_2 के मानों का परिकलन कीजिये ।



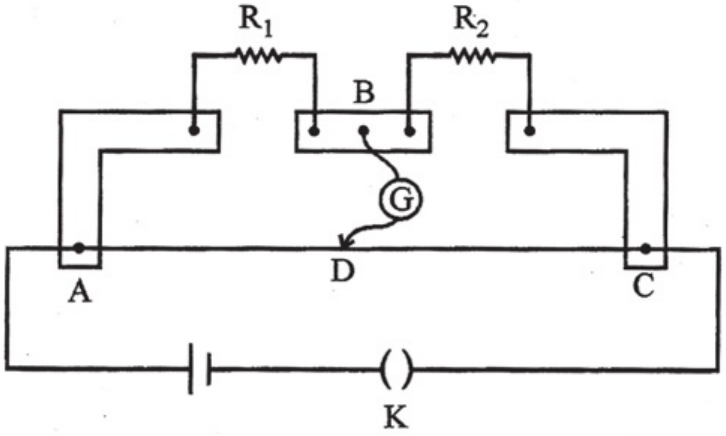
(a) State the working principle of a potentiometer. With the help of the circuit diagram, explain how a potentiometer is used to compare the emf's of two primary cells. Obtain the required expression used for comparing the emfs.

(b) Write two possible causes for one sided deflection in a potentiometer experiment.

OR

(a) State Kirchhoff's rules for an electric network. Using Kirchhoff's rules, obtain the balance condition in terms of the resistances of four arms of Wheatstone bridge.

(b) In the meterbridge experimental set up, shown in the figure, the null point 'D' is obtained at a distance of 40 cm from end A of the meterbridge wire. If a resistance of 10 Ω is connected in series with R_1, null point is obtained at AD = 60 cm. Calculate the values of R_1 and R_2.



29. (a) किसी एकसमान चुम्बकीय क्षेत्र में लटके हुए एक धारावाहित आयताकार पाश (लूप) पर लगने वाले बलयुग्म (टॉर्क) के लिये एक व्यंजक प्राप्त कीजिये ।

(b) एक प्रोटॉन तथा एक ड्यूटिरॉन के संवेग आपस में बराबर हैं । ये दोनों कण किसी एकसमान चुम्बकीय क्षेत्र में इस क्षेत्र की दिशा की लम्बवत् दिशा में प्रवेश करते हैं । इस चुम्बकीय क्षेत्र में इन दो कणों के प्रक्षेप-पथों को चित्रित कीजिये ।

अथवा

(a) एक छोटी चुम्बकीय सूई का चुम्बकीय आघूर्ण 'm' है । यह सूई किसी एकसमान चुम्बकीय क्षेत्र 'B' में मुक्त रूप से घूम सकती है और घूर्णन का अक्ष इस चुम्बकीय क्षेत्र की दिशा के लम्बवत् है । इस अक्ष के परित: चुम्बकीय सूई का जड़त्व आघूर्ण 'I' है । चुम्बकीय सूई को उसकी स्थायी स्थिति से थोड़ा सा विस्थापित कर छोड़ दिया जाता है । सिद्ध कीजिये कि सूई सरल आवर्त गति करती है । इससे सूई के आवर्तकाल के लिये एक व्यंजक प्राप्त कीजिये ।

(b) एक चुम्बकीय सूई ऊर्ध्वाधर समतल में मुक्त रूप से घूम सकती है । यह सूई पृथ्वी में किसी स्थान पर इस प्रकार अभिमुख (स्थित) हो जाती है कि उसका अक्ष ऊर्ध्वाधर रहता है । तो उस स्थान पर (i) पृथ्वी के चुम्बकीय क्षेत्र के क्षैतिज घटक, तथा (ii) नमन (नति) कोण, का मान ज्ञात कीजिये ।

(a) Derive the expression for the torque on a rectangular current carrying loop suspended in a uniform magnetic field.

(b) A proton and a deuteron having equal momenta enter in a region of uniform magnetic field at right angle to the direction of the field. Depict their trajectories in the field.

OR

(a) A small compass needle of magnetic moment 'm' is free to turn about an axis perpendicular to the direction of uniform magnetic field 'B'. The moment of inertia of the needle about the axis is 'I'. The needle is slightly disturbed from its stable position and then released. Prove that it executes simple harmonic motion. Hence deduce the expression for its time period.

(b) A compass needle, free to turn in a vertical plane orients itself with its axis vertical at a certain place on the earth. Find out the values of (i) horizontal component of earth's magnetic field and (ii) angle of dip at the place.

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Senior School certificate Examination

Marking Scheme - Physics (C0de 55/1/1)

1. The marking scheme provides general guidelines to reduce subjectivity in the marking. The answers given in the marking scheme are suggest ed answers. The content is thus indicated. If a student has given any other answer, which is different from the one given in the marking scheme, but conveys the moaning correctly, such answers should be given full weightage.

2. In value based questions, any other individual response with suitable justification should also be accepted even if there is no reference to the text.

3. Evaluation is to be done as per instructions provided i n the marking scheme. It should not be done according to one' s own interpretation or any other consideration. Marking schemer should be adhered to and religiously followed

4. If a question has parts, please award in the right hand side for each part. Marks awarded for different part of the question should then be totaled up and written in the left hand margin and circled

5. If a question does not have any parts, marks are to be awarded in the left hand margin only.

6. If a candidate has attempted an extra question marks obtained in the question attempted first should be retained and the other answer should be scored out.

7. No marks are to be deducted for the cumulative effect of an error. The student should be penalized only once.

8. Deduct ½ mark for writing wrong wits, missing units, in the final answer to numerical problem.

9. Formula can be taken as implied from the calculations even if not explicitly written.

10. In short answer type question, asking for two features/ characteristics / properties if a candidate writes three

features, characteristics / properties or more, only the correct two should be evaluated

11. Full marks should be awarded to a candidate if his / her ans were in a numerical problem is close to the value given in the scheme.

12. In compliance to the judgement of the Hon' lie Supreme Court of India, Board has decided to provide photocopy of the answer book(s) t o the candidates who will apply for it along with the requisite fee from 2012 examination Therefore, it is all the more important that the evaluation is done strictly as per the value points given i n the marking scheme so that the Board could be in a position to defend the evaluation at any forum

13. The Examiner shall also have to certify in the answer book that they have evaluated thc ans were book strictly in accordance with the value points given in the marking scheme and correct set of question paper.

14. Every Examiner shall also ensue t hat all the answers are evaluated, marks carried over to the title paper,correctly totaled and written in figures and words.

15. In the past it has been observed t hat the foil owing are the common types of errors committed by the Examiners

- Leaving ans were or part there of unassessed in an answer
- Giving more marks for an answer than assigned to it or deviation from the marking scheme.
- Wong transference of marks from the inside pages of the answer book t o the title page.
- Wong question wise totaling on the title page.
- Wrong totaling of marks of the two columns on the title page.
- Wrong grand total.
- Marks in words and figures not tallying
- Wong transference to marks from the answer book to awards list.
- Answer marked as correct ( ) bit marks not awarded
- Half or part of ans were marked correct ( ) and the rest as wrong ( ) but no milks awarded

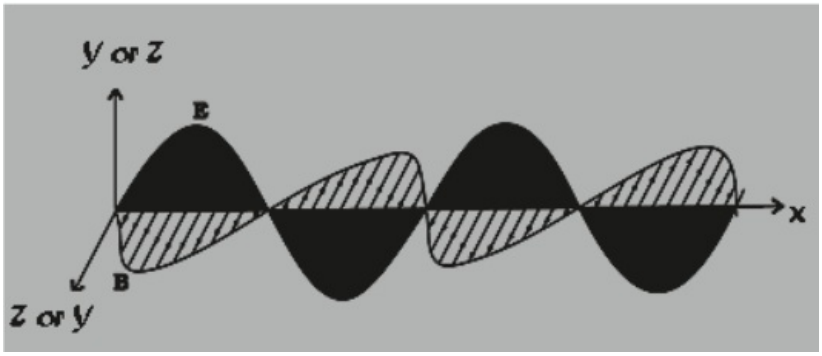
16. Any unassessed portion non earring over of marks t o the title page or totaling error detected by the candidate shall damage the prestige of all the personnel engaged i n the evaluation work as also of the Board Hence in order to uphold the prestige of all concerned, it is again reiterated that the instructions be followed meticalously and judiciously.

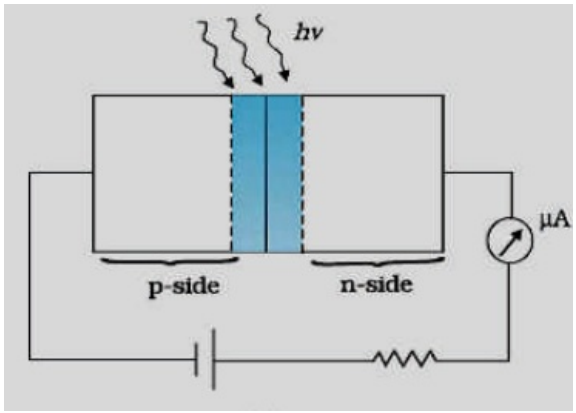
MARKING SCHEME

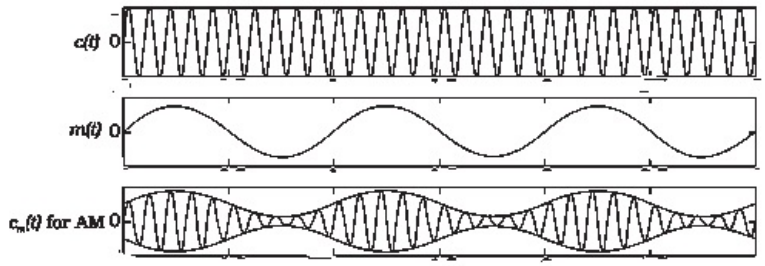
SET 55/1/1

Q.No	Expected Answer/Value Points	Marks	Total Marks
1.	Substances, which at room temperature, retain their ferromagnetic property for a long period of time are called permanent magnets. Alnico, cobalt, steel and ticonal (any one)	½ +½	1
2.	Spherical	1	1
3.	Heat Waves, as they are transverse/electromagmetic in nature	½ +½	1
4.	Magnitude of conduction & displacement current are Zero	1	1
5.	A+ δ_m = 2i	1	1
6.	(1,3) and (2,4)	½ +½	1
7.	$i = \frac{V}{R} = \frac{190}{38} = 5A$ Awardfull mark if student calculates current directly	½ +½	1

8.	Because the cell has some finite internal resistance./Enf is determined when the cell is in open circuit and no current directly.	1	1
9	Conditions ½+½ Relation 1 (a) i) Ray of light should travel from denser to rarer medium ii) Angle of incidence should be more than the critical angel. (b) $\mu = \frac{1}{\sin i_c}$ Where i_C is the critical angel	½ ½ 1	2
10.	Statement of Lenz law 1 Enf and justification ½+½ The polarity of induced emf is such that it tends to produce a current which opposes the change in magnetic flux that produced it. Yes, as the magnetic flux due to vertical component of Earth's magnetic keeps on changing as the metallic rod falls down.	1 ½+½	2
11.	Determination of power 1½ Nature ½ Power of convex lens, Power of concave lens Power of the combination $P=P_1+P_2=-1D$ Nature: Diverging	½ ½ ½ ½	2
12.	(i) Value of Shunt Resistance 1 (ii) Combined resistance 1 **(i) Shunt** $S = \frac{R_A i_g}{i - i_g}$ $= \frac{0.8 \times 1.0}{5.0 - 1.0} = 0.2\Omega$ **(ii) Combined resistance of ammeter and shunt** $\frac{1}{R_{total}} = \frac{1}{R_A} + \frac{1}{S}$ $= \frac{1}{0.8} + \frac{1}{0.2}$ $R_{total} = \frac{0.8}{5}$ $\Rightarrow R_{total} = 0.16\Omega$	½ ½ ½ ½	2

13.	(i) Effect on Brightness of the blib and reason ½+½ (ii) Effect on volt meter reading and reason ½+½ (i) Increases. As the value of the base current increases, the collector current will increase proportionately. (ii) Increases. Due to increase in collector current, voltage drop across lamp will increase.	½ ½ ½ ½	2
14.	(a) Sketch of propagation 1½ (b) Relation ½ (a)  [NOTE: Accept the alternative choices indicating the correct directions of the oscillating component of E and B] (b) $\frac{E_0}{B_0} = c$	1½ ½	2
15.	Identification of X and Y 1½ Function of X and Y ½ X: IF stage Y: Amplifier The Carrier frequence is changed to lower frequency by intermediate frequence	½ ½ ½ ½	2
	Circuit diagramand working 1½ It use to detect the optical signal ½		

16.	Circuit diagram of an illuminated photodicode  When the photo diode is illuminated with radiations (photons) with energy (hv) greater than the energy gap(Eg) of the semi conduct or, then electron- hole pairs are generated due to the absorption of photons. The junction field sends the electrons to n-side and holes to p-side to produce the emf. Hence current flows through the load when connected It is easier to observe the change in the current with change in the radiation intensity, if a reverse bias is applied. Thus photo diode can be used as a photo detect or to detect optical signals. OR Important considerations 1 Order of band gap 1 1. It is a heavily doped p-n junction 2. The reverse breakdown voltages of LEDs are very low 3. The semi conduct or used for fabrication of visible LEDs; must at least have a band gap of 1.8 e V (Any tow of the above) Order of band gap is about 3 e V to l.8 e V	½ 1 ½ ½+½ 1	2
17.	Important factor justifying the need of modulation 1½ Diagrams showing how AM wave is obtained 1½ 1. Practical Size of the antenna or aerial 2. Effective power radiated by an antenna 3. Mixing up of signals from different transmitters	½ ½ ½ ½ ½	



½ 3

18.

(i) Calculation of potential V and unknown Capacitance C	1½
(ii) Calculation of charge stored O	1½

½

(i) ½

Q=CV ½

½

½

Substituting the value of C ½

Potential V=180 V ½

(ii) Charge stored when voltage is increased by 120 V

OR

(i)	Calculation of net electric flux	2
(ii)	Calculation of charge	1

(i) The magnitude of the electric field at the left face is E= 50 NC^{-1} ½

Therefore flux through this face ½

$= 360$

$120 = 360$

$= 240$

$\Rightarrow$ Capacitance $C = 2$

The magnitude of the electric field at the right face is E=100 NC^{-1}

Therefore flux through this face ½

Q = 2

= 600 ½

½

(ii) Charge enclosed by the cylinder ½

C

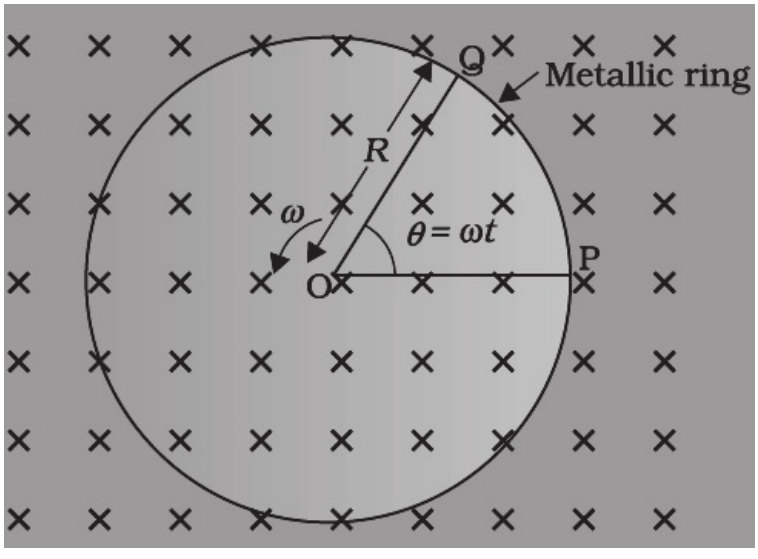
3

19.

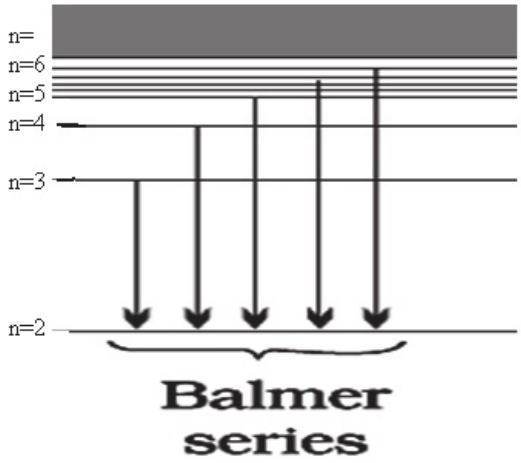
(i) Cause of release of energy	1
(ii) Proff for independence of nuclear density on mass number	2

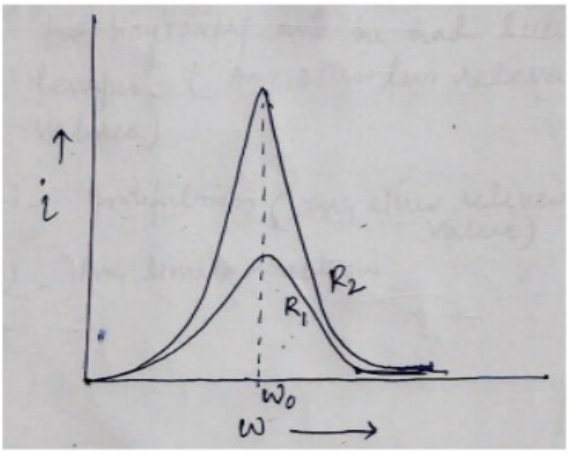
(a) Since the total initial mass of nuclei on the lefy side of reaction is greater than the total final mass of nucleus on the right hand side, this difference of mass appears the energy rleased. 1

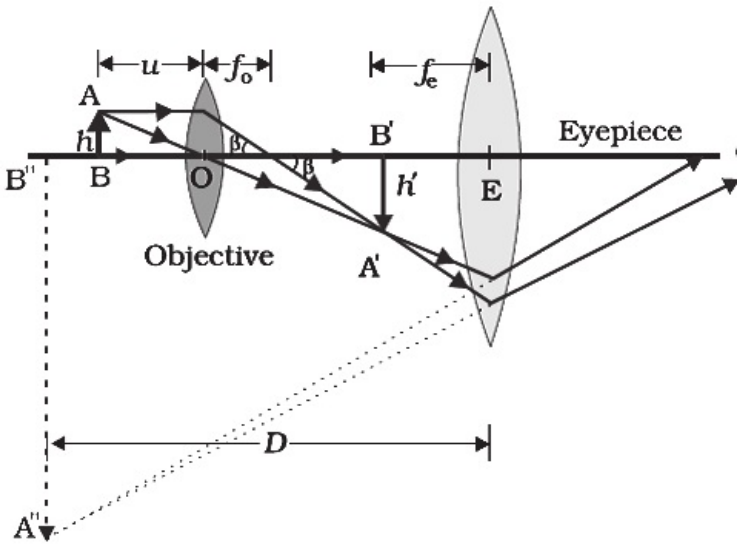
½

	$A_s = R_0 A^{1/2}$	½ ½ ½	
20.	(a) Reasons of failure of wave the theory to explain Photoelectric effect. 1½ (b) Basic features of Photon picture 1½ (a) According to wave theory (i) The maximum kinetic energy of the emitted electron should be directly proportional to the intensity of incident radiations but it is not observed experimentally. Also maximum kinetic energy of the emitted electrons should not depend upon incident frequency according to wave theory, but it is not so. (ii) Electron emmission should take place at all frequencies of radiations i.e there should not exist the threshold frequency. This fact contradicts experimental observation (iii)There should be a time lag in photoelectric emmission but according to observation photoelectric emmission is instantaneous (b) According to photon picture (I) Each quantum of radiation has energy hv (ii) In photoelectric effect the electrons in the metal absorbs this quantum of energy (hv) (iii) When this energy exceeds the minimum energy needed for the	½ ½ ½ ½ ½	3
21.	(i) Explanation, how emf is induced 1½ (ii) Derivation of the expression 1½  	½	

	As the rod is rotated, free electrons in the rod move towards the outer end due to Lorentz force and get distributed over the ring Thus the resulting separation of charges produces as emf across the end of the rod. The Magnitude of the emf generated across the lenght 'dr' of the rod as it moves at right angle to the magnetic fields is given by	1 ½ ½ ½	3
22.	Determination of (i) Dynamic output resistance ½+½ (ii) dc current gain ½+½ (iii) ac current gain ½+½ (1) Dynamic output resistance $r_0 = \left(\frac{\Delta V_{CE}}{\Delta I_C}\right)_{I_b}$ $= 0.2$ mA $r_0 = \frac{}{} = 20\ K\Omega$ (2) dc current gain, at 10 V, $I_C = 3.6$ mA $\beta = \frac{I_c}{I_b} = \frac{3.6x10^{-3}}{30x10^{-6}} = 120$ (3) ac current gain $\Delta I_b = 40\ \mu A - 30\ \mu A = 10\ \mu A$ $\Delta I_c = 4.7$ mA $- 3.6$ mA $= 1.1$ mA $\beta_{ac} = \left(\frac{\Delta I_c}{\Delta I_b}\right)$ From the graph $= \frac{1.1x10^{-3}(12 - 8)}{10x10^{-6}(3.7 - 3.5)} = 110$ [NOTE: Credit should also be given to candidate who uses the right procedure, but considers the values slightly different from those used above]	½ ½ ½+½ ½ ½	3

23.	Derivation of expression for total energy of the electron 2 Energy level digram for Balmer series 1 From (i) and (ii) Kinetic energy Potential energy ⇒ (ii) Total Energy TE=KE+U ⇒ Energy Level Digram of Balmer Series  	½ ½ ½ ½ 1	3
24.	(a) Relationship between interference pattern and diffraction from each slit 1 (b) Calculation of separation between the position of first maxima of two Wavelengths 2 a) In double slit experiment, the pattern on the screen is actually a super position of single slit defraction from each slit and double slit interference pattern As a result, there appears a broader diffraction peak in which there occur several fringes of s miller widths due to double slit interference. b) Distance of first secondary maximum from center of the screen	1 ½ ½ ½	

	$x = \frac{3}{2}\frac{D\lambda}{a}$ Therefore spacing between first secondary maxima on the screen for two given wavelengths $\Delta x = \frac{3D}{2a}(\lambda_2 - \lambda_1)$ $= \frac{3\times1.5}{2\times2\times10^{-4}}(596-590)\times10^{-9}$ $= \frac{4.5\times6\times10^{-5}}{4}$ $=6.75\times10^{-5}$ m	½	3
25.	Plot of variation of current with angular frequency 1 Condition for resonance ½ Value of resistance for sharper resonance 1 Definition of Q—fact or and its significance ½  Condition for resources $X_L=X_C$ Resources will be shaper for resistance R_2 Significance of Qfactor For large Qfactor, resonance will be sharper and therefore circuit will be more selective	1 ½ ½ ½	3
26.	(i) Four parts 1 mark for each part a) Because during thunder storm car would act as an electrostatic shield b) D. Pathak displayed values of safety of human life, helpfulness, empathy and scientific temper, (tr any other relevant values) c) Gratefulness , indebtedness ((or any other relevant value) d) Example of any similar action	1 ½+½ 1 1	4
	(a) Ray diagram showing image formation 1½ Derivation of expression fa magnification 1½ (b) Distinction between myopia and hyper metropia 1½ Correction of defects by diagram 1½		



5

Magnification of objective

$$m_0 = \frac{h'}{h} = \frac{L}{f_0}$$

Angular magnification due to eyepiece

1

Total magnification when image is formed at infinity ½

$m=m_0 m_e$ ½

(b)

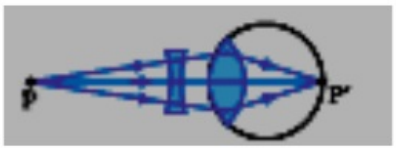
Myopia	Hyper metropia
1. Distant object arriving at the eye lens get converged at a point in front of the retina	1.Eyelens focuses the incoming light behind retina
2. The eye ball is elongated	2. The eye ball is shortened
3. Person cannot see distant objects clearly	3. Person cannot see nearby objects clearly.

½

½

(Any two or any other correct answer) ½+½

27.



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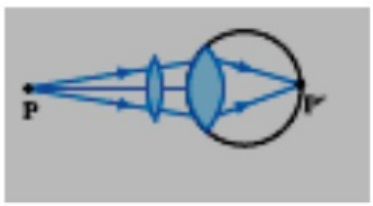


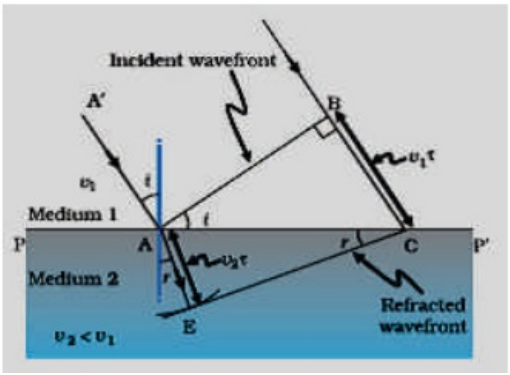
Myopia can be corrected by interposing a concave lens between eye and object	Hyper metropia can be interposing a convex lens between eye and object	½+½	5

[Award only half mark if diagrams not drawn, award full mark even if explanation is not written]

OR

(a) Statement of Huygen's principle	1
Diagram	1
Verification of Snell's law	1
(b) Explanation of (i) and (ii)	1+1

(a) According to Huygens principle, each point of the wavefront is the source of a secondary disturbance and the wavelets emanating from these points spread out in all directions with the speed of the wave. A common tangent to all these wavelets, gives the new position of the wavefront at a later time. 1



1

Verification od Snell'law ½

From figure

$$\sin i = \frac{BC}{AC} = \frac{v_1 t}{AC}$$ ½

$$\sin r = \frac{AE}{AC} = \frac{v_2 t}{AC}$$

$$\frac{\sin i}{\sin r} = \frac{v_1}{v_2} = \mu$$ 1

(b) Yes, 1

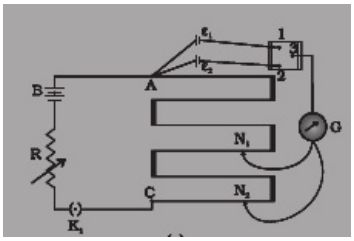
(i) Reflection and refraction arise through interaction of incident light with the atomic consituents of matter. Atoms may be viewed as oscillators, which take up the frequency of the external agency (light) causing forced oscillators. The frequency of light emitted by a chargred oscillator equals its frequency of oscillation. Thus, the frequency of scattered light equals the frequency of incident light. [Any other correct explanation] 5

(ii) No, Energy carried by a wave depends on the amplitude wave, not on the speed of wave propagation.

(a) Working principle of potentiometer	1
Diagram	1
Expression	1
(b) Two possible causes for one sided deflection	1+1

(a) Principle: When a constant current flows through a wire of uniform area of cross section then potential difference between two points on the wire is directely proportional to length of this section of wire.

vαl



1

1

$$\Rightarrow \frac{\varepsilon_1}{\varepsilon_2} = \frac{l_1}{l_2}$$

½

(b) (i) When the driver cell/source cell has emf less then the emf of the cells to be compared

½

1

(ii) When the postitive end of the potentio meter is connected to negative terminal of the cell whose emf is to be compared/ determined

1

OR

(a) Statement of Kirchhoff's rule	½+½
Obtaining the balance condition in Wheatst on Bridge	2
(b) Two possible causes for one sided deflection	2

5

28.

(a)(i) Algebraic sum of the currents entering the junction is equal to the sum of current leaving the junction.

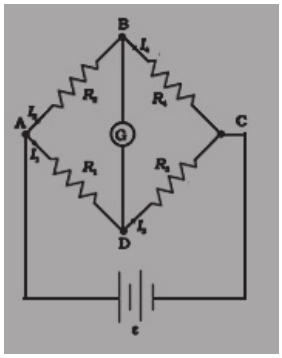
½

(ii) The Algebraic sum of the charges in potential around any closed loop involving resistors and cell is zero.

½

$\varepsilon = I_2$

[Alternatively accept the mathematical form of the kirchhoff's rule]



½

½

½

In loop ADBA
$-I_1 R_1 + 0 + I_2 R_2 = 0$
$\Rightarrow I_1 R_1 = I_2 R_2$ ½

In loop CBDC
$I_2 R_4 + 0 - I_1 R_3 = 0$
$\Rightarrow I_2 R_4 = I_1 R_3$ ½
$\Rightarrow \frac{R_1}{R_2} = \frac{R_3}{R_4}$ ½ 5

(b) $\frac{R_1}{R_2} = \frac{40}{60} = \frac{2}{3}$

$\frac{R_1 + 10}{R_2} = \frac{60}{40} = \frac{3}{2}$

$\frac{R_1}{R_2} + \frac{10}{R_2} = \frac{3}{2}$

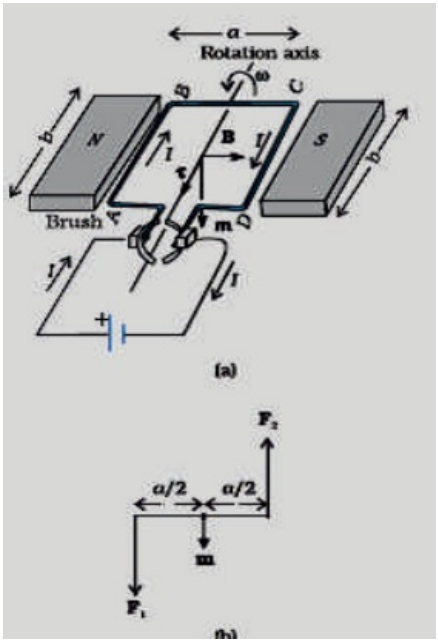
$\Rightarrow \frac{2}{3} + \frac{10}{R_2} = \frac{3}{2}$

$\Rightarrow R_2 = 12\,\Omega$

Substituting for R_2 and finding the value of R_1
$R_1 = 8\,\Omega$

(i) Derivation of the expression for the torque with diagram	3
(ii) Depicition of the trajectories	2

(a)



The Magnetic field exerts no force on the two arms AD and BC of the loop.
Force F_1 acts on arm AB directing into plane.

$F_1 = IbB = F_1$

Force F_2 acts on arm CD directing out of the plane

$F_2 = IbB = F_1$ 1

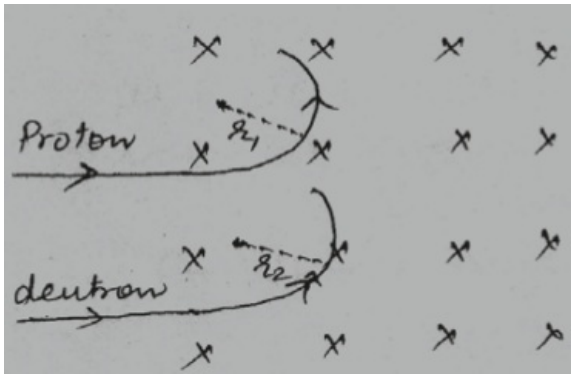
Hence there is a torque on the loop due to forces F_1 and F_2

$$= IbB\frac{a}{2} + IbB\frac{a}{2} = I(ab)B = I\,AB \text{ where } A=ab \text{ is the area of the loop}$$

½

½

(b) ½



½

29. 1

Here $r_1=r_2$

(Since the monmenta of charged particles are equal and they have equal charged, therefore they will describe circular trajectories of same radius) 1

[If the candidate only mentions that they describe circular tarjectories without the diagram, one mark should be awarded]

OR

5

(a) Execution of SHM of compass needle in magnetic field	2
Derivation of its time period	1
(b) Finding (i) horizontal component of earth's magnetic field (ii) angel of dip	1+1

(a) Torque acting on the compass needle suspended freely in a uniform magnetic field ½

It will be balanced by the restoring torque

For small angle sin $\theta \approx \theta$ ½

In equilibirum the resulting equation of motion ½

½

½

In Magnitude = MB sin θ

=- MB sin θ

[If the student just writes that the needle, ½

	(i) When slightly distrubed fromits stable position experiences a torque due to the magnetic field and (ii) writes the expression for this torque, Award (1+1=2)] (b) (i) Horizontal component of Earth's magnetic field =0 (ii) The value of angle of dip at that place = 90^{o}	1 1	5

NOTES

Document Outline